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Second Addendum to the Work Plan for the OU 7-13/14 Waste Area Group 7 Comprehensive Remedial Investigation/Feasibility Study

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ABSTRACT

This *Second Addendum to the Work Plan for OU 7-13/14* presents revised requirements for completing the Waste Area Group 7 comprehensive remedial investigation/feasibility study at the Idaho National Engineering and Environmental Laboratory. Waste Area Group 7 is synonymous with the Radioactive Waste Management Complex and includes a shallow landfill, a storage area for transuranic waste, and miscellaneous support operations.

Information developed throughout the remedial investigation/feasibility study process is cumulatively evaluated to assess data collection activities, review and revise assumptions, and modify the overall strategy for completing the study. Major scope elements include literature searches, laboratory analysis and bench-scale studies of retrieved waste, inventory assessment and mapping, probing and monitoring buried waste, environmental monitoring, technology-specific preliminary documented safety analyses and criticality study evaluations, modeling, baseline risk assessment, detailed analysis of remedial alternatives, and relative comparison of alternatives.

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ACRONYMS

ABRA	Ancillary Basis for Risk Analysis
AMWTF	Advanced Mixed Waste Treatment Facility
ANL-W	Argonne National Laboratory-West
ARAR	applicable or relevant and appropriate requirement
BRA	baseline risk assessment
CA	composite analysis
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CIDRA	Contaminant Inventory Database for Risk Assessment
COC	contaminant of concern
COPC	contaminant of potential concern
CSE	criticality safety evaluation
DEQ	Idaho Department of Environmental Quality
DOE	U.S. Department of Energy
DOE Idaho	U.S. Department of Energy Idaho Operations Office
EPA	U.S. Environmental Protection Agency
ERA	ecological risk assessment
FFA/CO	Federal Facility Agreement and Consent Order
FS	feasibility study
HDT	Historical Data Task
HI	hazard index
HQ	hazard quotient
ICP-MS	inductively coupled plasma-mass spectrometry
INEEL	Idaho National Engineering and Environmental Laboratory
INTEC	Idaho Nuclear Technology and Engineering Center

IRA	Interim Risk Assessment
ISG	in situ grouting
ISTD	in situ thermal desorption
ISV	in situ vitrification
LDR	land disposal restriction
LITCO	Lockheed Idaho Technologies Company
LLW	low-level waste
MCL	maximum contaminant level
NRF	Naval Reactors Facility
OCVZ	organic contamination in the vadose zone
OU	operable unit
PA	performance assessment
PDSA	preliminary documented safety analyses
PERA	Preliminary Evaluation of Remedial Alternatives
PRA	probabilistic risk assessment
PRG	preliminary remediation goal
RAO	remedial action objective
RCRA	Resource Conservation and Recovery Act
RD/RA	remedial design/remedial action
RFP	Rocky Flats Plant
RI/BRA	remedial investigation/baseline risk assessment
RI/FS	remedial investigation/feasibility study
ROD	record of decision
RPDT	Recent and Projected Data Task
RTD	retrieval, treatment, and disposal
RWMC	Radioactive Waste Management Complex

SDA	Subsurface Disposal Area
SIMS	secondary ion mass spectrometry
TRA	Test Reactor Area
TRU	transuranic
TSA	Transuranic Storage Area
USGS	U.S. Geological Survey
VOC	volatile organic compound
WAG	waste area group
WIPP	Waste Isolation Pilot Plant

Second Addendum to the Work Plan for the OU 7-13/14 Waste Area Group 7 Comprehensive Remedial Investigation/Feasibility Study

1. INTRODUCTION

The updated strategy for completing the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (42 USC § 9601 et seq., 1980) evaluation of the Radioactive Waste Management Complex (RWMC) at the Idaho National Engineering and Environmental Laboratory (INEEL) is specified in this *Second Addendum to the Work Plan for the OU 7-13/14 Waste Area Group 7 Comprehensive Remedial Investigation/Feasibility Study*. The U.S. Department of Energy Idaho Operations Office (DOE Idaho), the Idaho Department of Environmental Quality (DEQ), and the U.S. Environmental Protection Agency (EPA) developed a tri-party *Federal Facility Agreement and Consent Order for the Idaho National Engineering Laboratory* (DOE-ID 1991) to provide the framework for the CERCLA assessment of the INEEL. The RWMC is designated Waste Area Group (WAG) 7 in the *Federal Facility Agreement and Consent Order* (FFA/CO).

Though the FFA/CO originally listed 14 operable units (OUs) at the RWMC, OUs 7-13 and 7-14 were combined to comprise OU 7-13/14, the WAG 7 comprehensive remedial investigation/feasibility study (RI/FS). The RI/FS primarily focuses on the Subsurface Disposal Area (SDA), which is a radioactive waste landfill containing transuranic (TRU), mixed, and low-level waste (LLW). The RWMC, located in the southwest quadrant of the INEEL (see Figure 1-1), also includes a storage area for TRU waste and areas for administrative and support operations (see Figure 1-2).

Requirements for conducting the WAG 7 comprehensive RI/FS were documented in the original *Work Plan for Operable Unit 7-13/14 Waste Area Group 7 Comprehensive Remedial Investigation/Feasibility Study* (Becker et al. 1996) and the [*First*] *Addendum to the Work Plan for the Operable Unit 7-13/14 Waste Area Group 7 Comprehensive Remedial Investigation/Feasibility Study* (DOE-ID 1998). This *Second Addendum* reflects additional revisions to the original *Work Plan* arising from technical and programmatic considerations identified over the last 6 years.

1.1 Background

The *Work Plan* (Becker et al. 1996) specified the management framework, key assumptions, and requirements for conducting the WAG 7 comprehensive RI/FS as outlined in the original *Scope of Work for Operable Unit 7-13/14 Waste Area Group 7 Comprehensive Remedial Investigation/Feasibility Study* (Huntley and Burns 1995). The plan was predicated on the assumption that data to be provided by the OU 7-10 (Pit 9) process demonstration interim action (DOE-ID 1993), in conjunction with existing information, would be sufficient to complete the RI/FS.

Unexpected delays in the OU 7-10 Project prompted DOE-ID, DEQ, and EPA personnel to modify scope for OU 7-13/14. Modifications intended to expedite progress for OU 7-13/14 independent of OU 7-10 were outlined in the [*First*] *Revised Scope of Work for Operable Unit 7-13/14 Waste Area Group 7 Comprehensive Remedial Investigation/Feasibility Study* (LMITCO 1997) and specified in the *First Addendum* (DOE-ID 1998). However, independence of OUs was not practical because probing and coring the buried waste were planned for both OUs. Rather than develop two separate sets of drilling

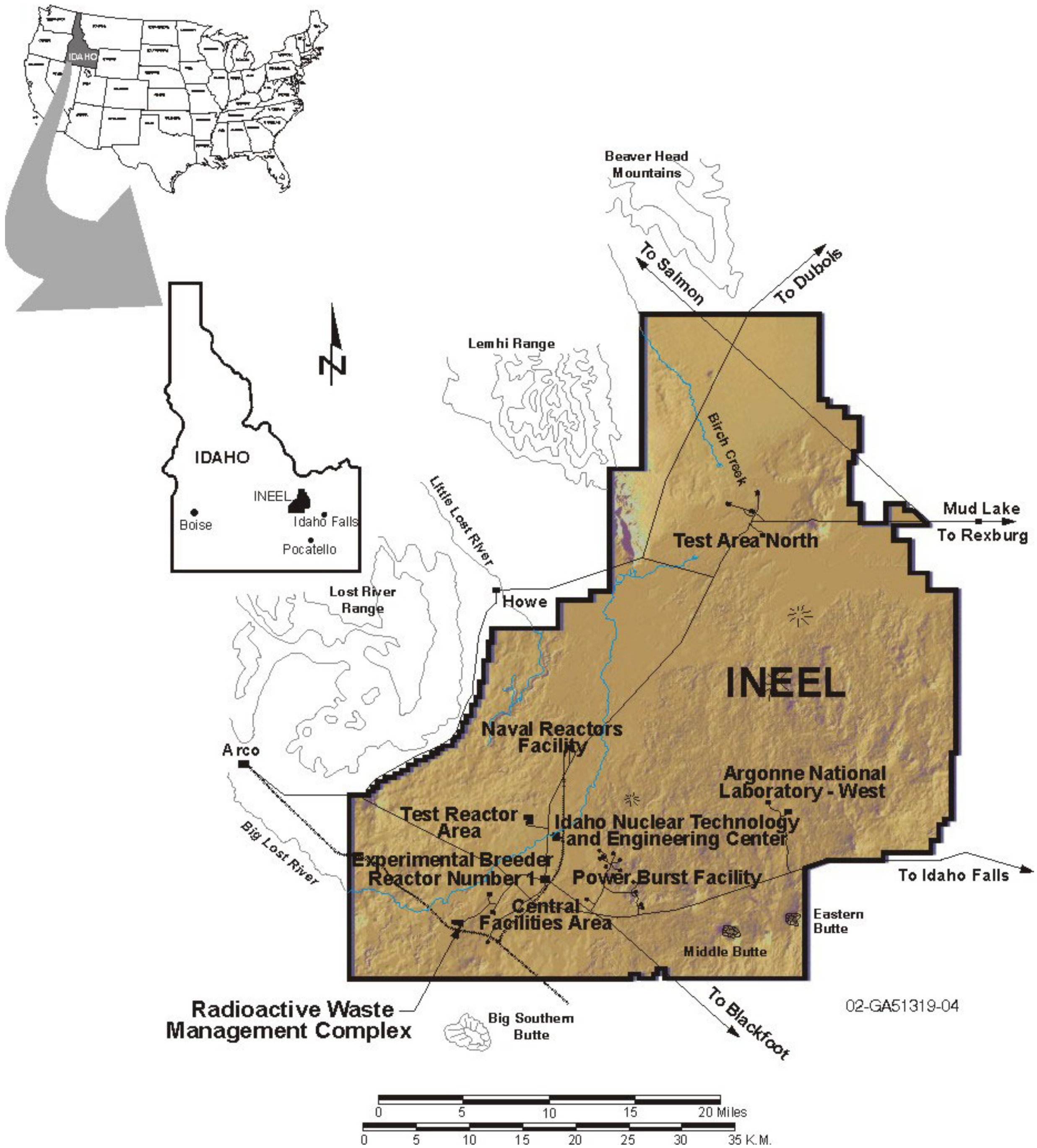

Figure 1-1. The Idaho National Engineering and Environmental Laboratory in southeast Idaho.

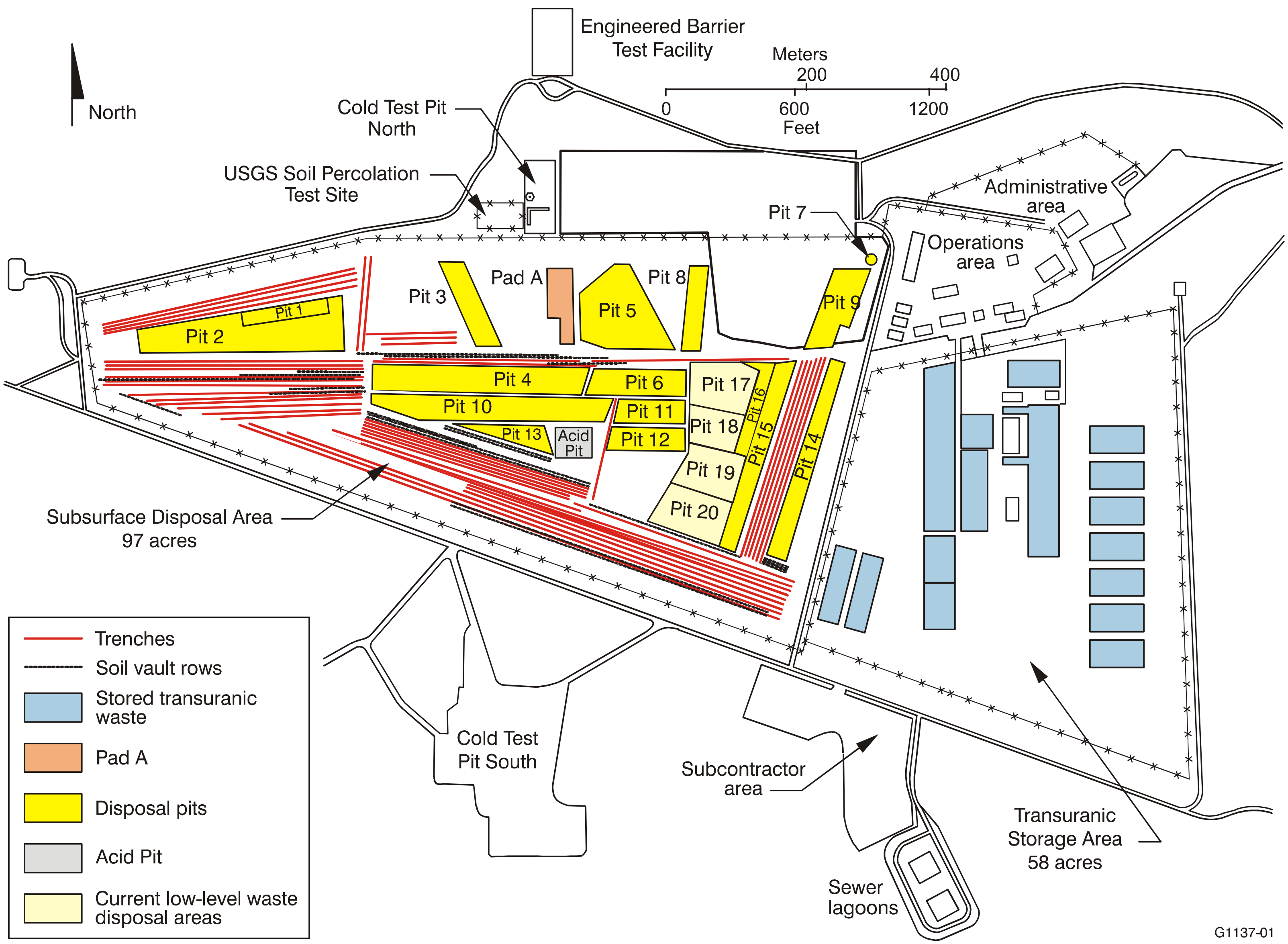

Figure 1-2. Waste Area Group 7, the Radioactive Waste Management Complex.

designs, safety analyses, technical procedures, and other components of similar work, the two projects collaborated to fulfill requirements. Work in Pit 9 was given priority because of schedule and budgetconstraints and to allow Pit 9 information generated by OU 7-10 to support the OU 7-13/14 comprehensive RI/FS. Many unanticipated technical and administrative difficulties arose. Probing was successfully implemented, but coring ultimately was abandoned in favor of a limited retrieval demonstration by the OU 7-10 Glovebox Excavator Method Project. Concurrently, technical and programmatic issues that affected implementation of treatability studies specified in the *First Addendum to the Work Plan* emerged under OU 7-13/14.

In spite of numerous obstacles, progress toward completion of the comprehensive RI/FS continued. Delivery of the draft RI/FS report to DEQ and EPA, in accordance with the enforceable schedule provided in the *First Revised Scope of Work*, was imminent when the OU 7-13/14 schedule was modified in the OU 7-10 *Agreement to Resolve Disputes, the State of Idaho, United States Environmental Protection Agency, United States Department of Energy* (DOE 2002) to accommodate additional delays in Pit 9. This agreement called for immediate submittal of a predraft remedial investigation/baseline risk assessment (RI/BRA) for OU 7-13/14 and delayed formal submittal of the OU 7-13/14 RI/FS by several years. The predraft RI/BRA was submitted to DEQ and EPA; DOE Idaho provided written responses to their comments in accordance with the schedule specified in this agreement.

Work conducted to support development of the comprehensive RI/FS was subsequently preserved in two published documents. The predraft RI/BRA was finalized as the *Ancillary Basis for Risk Analysis of the Subsurface Disposal Area* (Holdren et al. 2002). Work completed toward the feasibility study (FS) component of the OU 7-13/14 RI/FS was published as the *Preliminary Evaluation of Remedial Alternatives for the Subsurface Disposal Area* (Zitnik et al. 2002). These two documents have no formal standing under the FFA/CO. However, they provide a foundation for revising OU 7-13/14 scope to reflect the modified schedule.

The *Second Revision to the Scope of Work for the Operable Unit 7-13/14 Waste Area Group 7 Comprehensive Remedial Investigation/Feasibility Study* (Holdren and Broomfield 2003) was developed by DOE-ID, DEQ, and EPA to formalize agreements negotiated for OU 7-13/14 and to revise the enforceable milestones and schedule. Subsequent to publication of *Second Revision to the Scope of Work* (Holdren and Broomfield 2003), a federal court ruled (U.S. District Court 2003a) that a *Settlement Agreement* (DOE 1995) addressing removal of TRU waste from the RWMC is not limited to stored waste but also applies to TRU waste buried in the SDA. The ruling is being appealed by DOE (U.S. District Court 2003b). The *Settlement Agreement* was negotiated by DOE, the State of Idaho, and the U.S. Department of the Navy independent of the CERCLA assessment for the INEEL being conducted by DOE, DEQ, and EPA under the FFA/CO (DOE-ID 1991). However, DOE, DEQ, and EPA agreed that development of the OU 7-13/14 RI/FS will continue as planned because scope includes evaluation of a TRU retrieval alternative (Holdren and Broomfield 2003). Therefore, the OU 7-13/14 RI/FS will provide a basis for remediation of the SDA regardless of the outcome of the appeal. This *Second Addendum* specifies scope elements that must be completed under the comprehensive RI/FS to support remedial decisions for WAG 7. Appendix A contains the most recent agreements reached by DOE, DEQ, and EPA on scope for OU 7-13/14.

1.2 Objectives

The overall objective of the *Second Addendum* is to define tasks in accordance with the framework provided in the *Second Revision to the Scope of Work* (Holdren and Broomfield 2003) that must be implemented to meet objectives for the WAG 7 comprehensive RI/FS. Objectives for the RI/FS were defined in the original *Work Plan* (Becker et al. 1996) and augmented in its *First Addendum* (DOE-ID 1998). This *Second Addendum* consolidates the RI/FS objectives into three primary elements:

- Assess nature and extent of contamination associated with WAG 7

- Estimate current and future cumulative and comprehensive risks posed by WAG 7 and identify human health and environmental contaminants of concern (COCs)

- Develop and evaluate appropriate remedial alternatives based on nine CERCLA criteria to address WAG 7 COCs.

To fulfill these objectives, information contained in the *Ancillary Basis for Risk Analysis* (ABRA) (Holdren et al. 2002) and the *Preliminary Evaluation of Remedial Alternatives* (PERA) (Zitnik et al. 2002) will be combined with additional information that is developed within the constraints of scope, schedule, and budget for completing the comprehensive RI/FS. Additional sources include literature searches, environmental monitoring, the OU 7-08 Organic Contamination in the Vadose Zone (OCVZ) Project, the OU 7-10 Glovebox Excavator Method Project, and activities implemented by the OU 7-13/14 Project (e.g., waste zone mapping, probing, column studies, treatability studies, safety bases for remedial actions, criticality evaluations, and bench-scale tests).

1.3 Scope

The complexity of WAG 7 and the multiyear duration of the comprehensive RI/FS necessitate periodic reevaluation of project strategy by DOE-ID, DEQ, and EPA. Robust evaluation is a cumulative and iterative process that can be modified as information becomes available. This *Second Addendum* documents significant revisions to strategies developed in the original *Work Plan* (Becker et al. 1996) and its *First Addendum* (DOE-ID 1998). Elements that are not modified are neither repeated in nor superseded by this *Second Addendum*. Scope for the *Second Addendum* comprises the following:

- Describe progress and status of tasks implemented subsequent to publication of the *First Addendum* (i.e., since 1998)

- Review and revise assumptions that underlie development of the RI/FS and remedial decisions

- Specify activities to complete the RI/FS and subsequent decision documents

- Establish the technical and programmatic framework for completing the RI/FS, terminating with publication of a record of decision (ROD) for OU 7-13/14.

In addition to activities specified as scope for OU 7-13/14, DOE is performing non-time-critical removal actions to address risk posed by waste buried in the SDA. Two non-time-critical removal actions that are being initiated in 2004 include retrieval of waste from Pit 4 and encapsulation of beryllium blocks. Though the actions are being conducted outside of the RI/FS, DEQ and EPA agree that such actions are appropriate and within DOE's authority. These non-time-critical removal actions are consistent with overall objectives for OU 7-13/14. Relevant information obtained during pre-ROD actions will be incorporated into the RI/FS.

1.4 Second Addendum Organization

The *Second Addendum* is organized as follows:

- Section 2—Second Addendum Rationale—This section presents key assumptions and constraints for the RI/FS, summarizes the status of activities defined in the *Work Plan* and its *First Addendum*, and outlines tasks for continued implementation of the OU 7-13/14 Project.

- Section 3—Remedial Investigation/Baseline Risk Assessment Development—This section describes the RI/BRA report and tasks to support its development. Activities implemented to date and planned to address the following topics are presented: basis for the RI/BRA, administrative interfaces, SDA inventory, characterization and monitoring, risk assessment, and development of the RI/BRA report as a primary document under the FFA/CO.

- Section 4—Feasibility Study Development—This section describes the FS report and tasks to support its development. Activities implemented to date and planned to address the following topics are presented: remedial action objectives (RAOs), detailed analysis of remedial alternatives, bench-scale tests, preliminary documented safety analyses (PDSAs), and analysis of applicable or relevant and appropriate requirements (ARARs).

- Section 5—Remedial Investigation/Feasibility Study Support Tasks—This section describes additional activities such as project planning, community relations, the Administrative Record, and development of remedial decisions. Working and enforceable schedules are described.

- Section 6—References.

- Appendix A—Operable Unit 7-13/14 Modeling.

- Appendix B—Corrections to Risk Estimates in the Ancillary Basis for Risk Analysis.

- Appendix C—Flow and Transport Model Evaluation.

- Appendix D—Source Term Model Evaluation.

2. SECOND ADDENDUM TO THE WORK PLAN RATIONALE

Rationale for this *Second Addendum* is to build on the foundation provided in the ABRA and PERA to develop the RI/BRA and FS. Data will be compiled from various sources, analyzed, and added to data from previous investigations. The combined body of information will provide sufficient support to develop the RI/BRA and FS. Key assumptions and constraints for the WAG 7 RI/BRA and FS and an evaluation of previous and ongoing data collection activities are presented in this section.

2.1 Key Assumptions and Constraints

Assumptions presented in the WAG 7 *Work Plan* (Becker et al. 1996) and its *First Addendum* (DOE-ID 1998) for development of the RI/BRA and FS were reviewed to reassess applicability. During the 6 years since the *First Addendum* was finalized, several assumptions have become obsolete and were either modified or deleted. Additional assumptions also were formulated. Analyses of the RI/BRA and FS assumptions are presented in Sections 2.1.1 and 2.1.2. Comparisons of the *Work Plan* and *First Addendum* assumptions to current modifications are tabulated for ongoing RI/BRA and FS development. Assumptions will be monitored for continued validity throughout development of the RI/BRA and FS, modified as appropriate, and documented in the final RI/BRA and FS reports.

2.1.1 Assumptions for the Remedial Investigation/Baseline Risk Assessment

The RI/BRA assumptions documented in the *Work Plan* (Becker et al. 1996) and its *First Addendum* (DOE-ID 1998) were revised to reflect available knowledge and information. Table 2-1 compares *Work Plan* and *First Addendum* assumptions to revised assumptions for the RI/BRA.

2.1.2 Assumptions for the Feasibility Study

The FS assumptions documented in the *Work Plan* (Becker et al. 1996) and its *First Addendum* (DOE-ID 1998) were revised to reflect available knowledge and information. Table 2-2 compares *Work Plan* and *First Addendum* assumptions to revised assumptions for the FS.

2.2 Evaluation of Data Collection Activities

The *Work Plan* (Becker et al. 1996) and its *First Addendum* (DOE-ID 1998) presented the status of RI/FS development at the time of publication, identified data necessary to progress toward completion, and explained the approach to either obtain or substitute for the necessary data. The *Work Plan* identified data gaps for source term, biotic, and subsurface models; human health and ecological risk assessments; probabilistic risk assessments; and contaminated environmental media. Ongoing and planned activities to fill each data gap were described.

The *First Addendum* updated the status of activities to fulfill data requirements and presented new data gaps identified during implementation of OU 7-10 and OU 7-13/14 activities. Findings were tabulated to show whether data generated from various studies and activities filled data gaps identified in the *Work Plan*.

Similarly, this *Second Addendum* evaluates data collection specified in the *First Addendum* and identifies how those requirements have been modified, substituted, or fully satisfied. The current work plan approach is to apply information in the ABRA (Holdren et al. 2002) to develop the RI/BRA and to use the PERA (Zitnik et al. 2002) as the basis for the FS. The ABRA presents the SDA baseline risk assessment, which will be updated based on additional information and modeling, incorporated in the

RI/BRA, and subsequently applied to the analysis of remedial alternatives in the FS. The RI/BRA will include density distribution maps of all COCs and additional contaminants that may pose safety issues in technology-specific PDSAs. Unique waste streams, such as beryllium blocks and waste that is similar to spent nuclear fuel or high-level waste and may exhibit some characteristics of these waste forms, also will be mapped in the RI/BRA.

Development of general response actions, remedial action objectives, technology and process option screening, and analysis of alternatives was presented in the PERA. The FS will focus on refining and improving the PERA detailed analysis of assembled alternatives to develop a well-supported comparative analysis of benefits and deficiencies provided by respective remedial alternatives. Fate and transport modeling and risk assessments will be performed to assess long-term effectiveness of alternatives analyzed in detail. These FS risk assessments will be used to compare relative effectiveness of alternatives in mitigating threats to human and ecological receptors. Assembled alternatives will differ primarily in the approach to remediation of TRU pits and trenches and Pad A.

Sections 2.1.1 and 2.1.2 outline key assumptions that guide the RI/BRA and FS activities in OU 7-13/14. Specific activities for OU 7-13/14 are outlined in Tables 2-3 and 2-4. As stated in the Second Revision to the Scope of Work (Holdren and Broomfield 2003) and reflected in Table 2-4, major changes to work scope since the First Revised Scope of Work and the First Addendum include the following:

- Replace coring through waste with installation and monitoring of Type A and Type B probes, materials retrieved from Pit 9 by the OU 7-10 Glovebox Excavator Method Project, inventory revisions, and buried waste information (waste zone mapping of shipments, electromagnetic information, and other data layers)
- Eliminate treatability studies for (1) in situ grouting (ISG) for containment during retrieval and (2) ex situ soil treatments
- Eliminate field-scale testing for ISG
- Limit pre-ROD testing to bench-scale laboratory investigations with surrogate waste, materials retrieved from Pit 9 by the OU 7-10 Glovebox Excavator Method Project, and stored waste retrieved from Pad A
- Use available PDSAs and criticality safety evaluations (CSEs) to screen and evaluate in situ thermal desorption (ISTD), ISG, and in situ vitrification (ISV), and rely on information from the Pit 4 non-time-critical removal action for information to assess retrieval, treatment, and disposal (RTD)
- Eliminate probabilistic risk assessment
- Conduct modeling for the RI/BRA as detailed in Appendix A
- Expand modeling for evaluation of long-term risks associated with candidate remedial alternatives for the FS.

Data gaps identified in the original *Work Plan* are listed in Table 2-3 along with descriptions of activities that satisfied the data gaps, revised assumptions that affect data requirements, and data requirements remaining in the planning or implementation stages. Additional data gaps were identified in the *First Addendum*, primarily as a result of the *Interim Risk Assessment and Contaminant Screening for the Waste Area Group 7 Remedial Investigation* (Becker et al. 1998), delays in the OU 7-10 interim action, preliminary FS development, and reevaluation of key assumptions for the future RI/FS. These additional data gaps, related activities to fill the gaps, and the status of activities are presented in Table 2-4.

Table 2-1. Comparison of remedial investigation/baseline risk assessment assumptions in the *Work Plan* and *First Addendum* to *Second Addendum* assumptions.

Work Plan Assumption	*First Addendum* Assumption	*Second Addendum* Assumption
1. Waste disposed of in Pad A, Pits 1–20, Trenches 1–58, the soil vault rows, and the Acid Pit will be in the BRA. Only historical releases from the TSA will be addressed in the BRA. The TSA inventory and potential future releases will be addressed in a RCRA closure action (schedule not final to date).	1. Waste disposed of in the SDA (Pad A, Pits 1–20, Trenches 1–58, the soil vault rows, and the Acid Pit) will be evaluated in the BRA. The TSA will be addressed under CERCLA using information provided by the RCRA closure action (42 USC § 6901 et seq., 1976) and the Decontamination and Dismantlement Program. **Remark:** The assumption was revised to defer evaluation of the TSA under CERCLA until the facility is closed under RCRA.	1. No revision. Waste disposed of in the SDA (Pad A, Pits 1-20, Trenches 1–58, soil vault rows, and the Acid Pit) will be evaluated in the BRA. The TSA will be addressed under CERCLA using information provided by the RCRA closure action (42 USC § 6901 et seq., 1976) and the Decontamination and Dismantlement Program.
2. Carcinogenic risks and noncarcinogenic HQs will be calculated for 1,000 years. Groundwater risks and HQs will be calculated for the maximum concentrations occurring within 10,000 years. Risks will be summed across pathways on a time-consistent basis.	2. Carcinogenic risks and noncarcinogenic HQs will be estimated for 1,000 years. Risks will be summed across pathways on a time- and space-consistent basis. **Remark:** Groundwater is addressed in Assumption 7.	2. No revision. Carcinogenic risks and noncarcinogenic HQs will be estimated for 1,000 years. Risks will be summed across pathways on a time- and space-consistent basis. (See number 7 below for groundwater.)
3. Only adult exposures will be assessed for base case. If the toxicity data show that children or infants are the sensitive population (e.g., nitrate ingestion by way of groundwater), this will be addressed on a case-by-case basis in the sensitivity study.	3. No revision. Only adult exposures will be assessed for base case. If the toxicity data show that children or infants are the sensitive population (e.g., nitrate ingestion by way of groundwater), this will be addressed on a case-by-case basis in the sensitivity study.	3. Standard exposure parameters will be applied. **Remark:** The ABRA evaluated both childhood and adult exposures for soil ingestion exposure pathways as recommended in U.S. Environmental Protection Agency guidance (EPA 1989). The RI/BRA also will use standard exposure parameters.
4. An occupational exposure scenario will be addressed for the first 100 years. After that time, a residential exposure scenario will be addressed.	4. An occupational exposure scenario will be addressed for the first 100 years to simulate institutional control of the INEEL. As recommended in the INEEL guidance for cumulative risk assessment (LMITCO 1995a), future occupational risks will be evaluated if risks greater than 1E-06 or HIs greater than 1 are estimated for the current occupational scenario. **Remark:** Residential exposure scenarios are addressed in the revision to Assumption 7.	4. No revision. An occupational exposure scenario will be addressed for the first 100 years to simulate institutional control of the INEEL. As recommended in INEEL guidance for cumulative risk assessment (LMITCO 1995a), future occupational risks will be evaluated if risks greater than 1E-06 or HIs greater than one are estimated for the current occupational scenario.

Table 2-1. (continued).

Work Plan Assumption	*First Addendum* Assumption	*Second Addendum* Assumption
5. Because of the different scope and assumptions of previous work, only limited comparisons will be made to previous risk assessments.	5. No revision. Because of the different scope and assumptions of previous work, only limited comparisons will be made to previous risk assessments.	5. No revision. Because of the different scope and assumptions of previous work, only limited comparisons will be made to previous risk assessments.
6. The receptor location is on the SDA for both the occupational and residential receptor. Intrusion into the waste will not be addressed quantitatively. In addition, groundwater risks at the INEEL boundary will be assessed.	6. The receptor location is on the SDA for the occupational scenarios. The future residential receptor will be located near, but not on, the SDA. Intrusion into the waste will not be quantitatively evaluated. **Remark:** The location of the future residential receptor is specified. Groundwater pathway scenarios for the residential receptor are given in the revision to Assumption 7.	6. The receptor location is on the SDA for occupational scenarios. An acute well-drilling scenario will be evaluated (see Section 4.5.3). Other intrusion scenarios will not be evaluated. For the current residential scenario, only groundwater risks at the INEEL boundary will be assessed. The location for the hypothetical future residential receptor is near, but not on, the SDA. See Appendix A for land-use assumptions. **Remark:** Receptor locations are clarified and an acute well-drilling scenario is added.
7. The well location for groundwater ingestion for the residential scenario will be that location at the INEEL boundary with the maximum aquifer concentration during the occupational control period. After occupational control, the groundwater ingestion will be based on the location anywhere within the Snake River Plain Aquifer with the maximum aquifer concentration.	7. The current residential groundwater ingestion scenario will be evaluated at the downgradient INEEL boundary for the 100-year institutional control period. The future residential exposure scenarios illustrated in the conceptual site model (see Section 3.2 of the *First Addendum*) will be evaluated for a 1,000-year period. Future residential groundwater ingestion will be evaluated at the time of peak concentration out to 10,000 years. Multiple simulated groundwater receptor locations will be illustrated by summing risks on a time-consistent basis and plotting risk contours. **Remark:** Simulating a floating receptor that appears, perhaps in multiple locations and at different times, wherever and whenever the simulated concentration is highest is unrealistic and has been eliminated.	7. The current residential groundwater ingestion scenario will be evaluated at the downgradient INEEL boundary for the hypothetical 100-year institutional control period. Future residential exposure scenarios, after the hypothetical institutional control period, will be evaluated at the time and location (e.g., at the SDA boundary) of peak concentrations out to 10,000 years. Multiple locations for simulated residential groundwater receptors will be illustrated by summing risks on a time-consistent basis and plotting risk contours. **Remark:** The assumption was revised for clarity.

Table 2-1. (continued).

Work Plan Assumption	*First Addendum* Assumption	*Second Addendum* Assumption
8. The inventory contained in the Historical Data Task and Recent and Projected Data Task as of December 1, 1995, will be used.	8. The most recent inventories in Contaminant Inventory Database for Risk Assessment will be used when the BRA is initiated. Projected disposal inventories through the end of active disposal operations also will be evaluated.	8. Updated best-estimate inventories through 2009 will be used for the RI/BRA and FS. **Remark:** The assumption was modified to reflect inventory revisions and use of best-estimate projections for the active LLW pit, which is assumed to close in 2009.
9. The fate and transport models will be calibrated using best-estimate disposal amounts. The BRA will provide reasonable maximum exposure risk assessments by looking at upper-bound disposal amounts.	9. The fate and transport models will be calibrated using best-estimate disposal amounts. Deterministic risks in the BRA will be estimated using both the best-estimate and the upper-bound disposal amounts. **Remark:** The BRA based on best-estimate disposal amounts will estimate reasonable maximum exposure risks. The BRA based on the upper-bound disposal quantities will provide additional information to support the feasibility study and remedial decision-making.	9. Limited model calibration achieved for the IRA was not improved for the ABRA. Several model refinements will be implemented for the RI/BRA and FS, achieving limited improvements to model calibration using best-estimate inventories. Updated VOC modeling is being conducted by OU 7-08 based on revised VOC inventories and adjustments to account for vapor vacuum extraction. The OU 7-08 results will be incorporated into the RI/BRA. **Remark:** Further attempts to calibrate will not be pursued because contamination in the environment is limited and does not provide adequate concentrations and trends for calibration targets.
10. Time-dependent waste emplacement will account for the yearly disposals of waste.	10. No revision. Time-dependent waste emplacement will account for the yearly disposals of waste.	10. No revision. Time-dependent waste emplacement will account for yearly disposals of waste.
11. Only contaminants identified in the human health-screening document (Becker et al. 1996) (Note: this reference is to the screening contained in appendices to the *Work Plan*) will be assessed. No new COPCs are expected.	11. The COPCs retained in Table 2-1 of the *First Addendum* will be assessed in the BRA.	11. Human health and ecological COCs for the RI/BRA are identified in the ABRA and the *Second Revision to the Scope of Work*. **Remark:** The constraint was modified to reference COCs.

Table 2-1. (continued).

Work Plan Assumption	*First Addendum* Assumption	*Second Addendum* Assumption
12. Credit for remediation of volatile organics under OU 7-08 will not be taken in the BRA because this remediation will not be completed before the start of the BRA.	12. The contaminant mass removed by the OCVZ Project will be simulated in the BRA fate and transport modeling.	12. The RI/BRA will incorporate VOC modeling, which will be completed in 2004 by the OU 7-08 OCVZ Project. Increased inventory and simulation of the contaminant mass removed by vapor vacuum extraction will be accounted for in the OCVZ model. **Remark:** Constraints were modified to account for revised VOC inventories and OCVZ operations.
	13. [New in *First Addendum*] The [ecological risk assessment] ERA will be a component of the FS study in conjunction with remedial alternatives and not quantified in the BRA.	13. The limited ERA contained in the ABRA will be updated in the RI/BRA based on improved inventory estimates. **Remark:** The ABRA included a limited ERA in response to an informal request from Idaho Department of Environmental Quality.
	14. [New in *First Addendum*] A simulated 100-year institutional control period inhibiting residential development on the INEEL will commence when the BRA is initiated (during the year 2000).	14. The simulated ABRA 100-year institutional control period from 2010 to 2110 will apply to the RI/BRA and FS. **Remark:** Remediation is assumed to occur instantaneously in 2010 as a basis for establishing the time frame for a hypothetical institutional control period for the RI/BRA and remediation of the SDA. An additional 100 years of institutional control is precludes unrestricted access until 2110. See Appendix A.
	15. [New in *First Addendum*] Contaminant profiles and leachate collected from Pits 4, 6, and 10 will be representative of the other pits and trenches that received similar waste streams.	15. Leachate from Type B probes will be used to qualitatively evaluate results of the ABRA and to support FS modeling. **Remark:** Type B probes have not yielded sufficient sample volumes to develop profiles.

Table 2-1. (continued).

Work Plan Assumption	*First Addendum* Assumption	*Second Addendum* Assumption
	16. [New in *First Addendum*] Ecological risk and human health risks by way of surface exposure pathways will be evaluated qualitatively in the BRA. **Remark:** The biotic uptake model was not calibrated in the IRA because of the FS assumption that future remedial actions at the SDA would include a cap that would inhibit biotic uptake. The capping assumption for the FS has been preserved.	16. Ecological risks quantified in the ABRA will be updated in the RI/BRA and surface exposure pathway risk for human health will be quantified. An acute well-drilling scenario comprises intrusion analysis. **Remark:** Scenarios were modified to include updates and appropriate exposure scenarios (see Appendix A).
		17. New. Waste and soil was retrieved from Pit 9 by the OU 7-10 Glovebox Excavator Method Project. Laboratory analysis is being managed under OU 7-10, and results are forthcoming. Data from analysis of OU 7-10 materials will be used in the RI/BRA for limited qualitative sensitivity analysis.

ABRA = *Ancillary Basis for Risk Analysis*
BRA = baseline risk assessment
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act
COC = contaminant of concern
COPC = contaminant of potential concern
DOE = U.S. Department of Energy
ERA = ecological risk assessment
FS = feasibility study
HI = hazard index
HQ = hazard quotient
INEEL = Idaho National Engineering and Environmental Laboratory
IRA = *Interim Risk Assessment* (Becker et al. 1998)
LLW – low-level waste
OCVZ = organic contamination in the vadose zone
OU = operable unit
RCRA = Resource Conservation and Recovery Act
RI/BRA = remedial investigation/baseline risk assessment
SDA = Subsurface Disposal Area
TSA = Transuranic Storage Area
VOC = volatile organic compound

Table 2-2. Comparison of feasibility study assumptions in the *Work Plan* and *First Addendum* to *Second Addendum* assumptions.

Work Plan Assumption	*First Addendum* Assumption	*Second Addendum* Assumption
1. Preliminary response actions will be developed for remediation of all COPCs and will later be revised to remediation of all COCs based on BRA results. Additionally, other hazardous constituents that have been identified in the SDA pits and trenches inventory will be evaluated to determine any notable effects these may have on technology performance. When appropriate, COPCs, and later COCs, will be grouped so that a given process would address more than one contaminant.	1. Preliminary response actions will be developed to remediate COPCs and will be revised later to focus on COCs identified in the BRA. In addition, other constituents in the SDA inventory will be evaluated to determine the potential notable effects on technology performance. When appropriate, contaminants will be grouped so that a given process addresses multiple contaminants. **Remark:** The assumption was revised to indicate that COPCs identified for further evaluation in the IRA would be used instead of all contaminants buried in the SDA to focus preliminary response actions.	1. Response actions were developed in the PERA to remediate COCs identified in the ABRA. If additional COCs are identified in the BRA, the response actions will be reevaluated. Other constituents in the SDA will be evaluated to determine potential notable effects on technology performance. When appropriate, contaminants will be grouped so that a given process addresses multiple contaminants. **Remark:** The assumption was revised to indicate that COCs identified in the ABRA and BRA will be used to focus response actions.
2. When screening for short-term and long-term effectiveness, the risk of each alternative will be assessed, including the risk associated with implementation of the alternative. This assessment will include consideration of all hazardous constituents known to be in the SDA pits and trenches inventory.	2. When screening for short-term and long-term effectiveness, the risk of each alternative will be assessed, including the risk associated with implementation of the alternative. This assessment will include consideration of all hazardous constituents in the SDA as documented in CIDRA. **Remark:** The assumption was revised to specify the inventories in CIDRA and to remove the implied exclusion of the soil vaults.	2. When screening for short-term and long-term effectiveness, the risk of each alternative will be assessed, including risk associated with implementation of the alternative. This assessment will include consideration of all hazardous constituents in the SDA as documented in inventory data compiled through 2004 and projected through 2009. **Remark:** This assumption was revised to specify waste inventory data compiled through 2004 and projected through 2009.

Table 2-2. (continued).

Work Plan Assumption	*First Addendum* Assumption	*Second Addendum* Assumption
3. Currently, not enough information is available on spatial location of contaminants in the SDA to evaluate location-specific response actions such as removal of a particular contaminant from a specific area within the SDA (with few exceptions). In the absence of this information, a maximum and average concentration of a given COPC in a specified soil volume will be assumed for evaluating response actions. A task has been identified to determine if some pits or trenches could be excluded from consideration for remediation, based on that pit or trench not having received shipments containing COPCs (later to be revised for COCs).	3. To evaluate response actions, estimates of maximum and average concentrations of a given COPC in specified soil and waste volumes will be based on disposal records. New spatial distribution information will be analyzed as it becomes available to determine whether location-specific response actions to remove particular contaminants can be implemented. Based on the revised spatial distribution information, some disposal areas may not be considered for remediation. **Remark:** The assumption was revised for clarity and to acknowledge that further research will be conducted that may justify revising Assumption 3.	3. To evaluate response actions, estimates of maximum and average concentrations of COCs in disposal locations will be based on disposal records and probing data. New spatial distribution information will be analyzed as it becomes available to determine whether location-specific response actions should be implemented. Remediation of some disposal areas may be modified based on revised spatial distribution information. **Remark:** The assumption was revised to include data collected from probing for determining spatial distribution of COCs.
4. Currently, it is assumed that a risk number of 1×10^{-4} or greater will require remediation, and the risk-based remediation goal will be 1×10^{-6}.	4. Preliminary remediation goals will be based on carcinogenic risk of 1E-04 and an HI of 1.0. Remedial action will be implemented if media concentrations are greater than background values and one of the following conditions is true: • The estimated carcinogenic risk is greater than 1E-04 • The predicted hazard index is greater than 1 for the soil pathways, greater than 1 for the groundwater pathway, and greater than 2 for both pathways combined • Simulated aquifer concentrations exceed MCLs. **Remark:** The assumption was revised to add hazard indices, preclude remediating concentrations less than background values, and address MCLs.	4. No revision. Preliminary remediation goals will be based on carcinogenic risk of 1E-04 and an HI of 1.0. Remedial action will be implemented if media concentrations are greater than background values and one of the following conditions is true: • Estimated carcinogenic risk is greater than 1E-04 • Predicted HI is greater than 1 for soil pathways, greater than 1 for the groundwater pathway, and greater than 2 for both pathways combined • Simulated aquifer concentrations exceed MCLs.

Table 2-2. (continued).

Work Plan Assumption	*First Addendum* Assumption	*Second Addendum* Assumption
5. There is no spent nuclear fuel or high-level waste in the SDA.	5. Waste buried in the SDA before 1970 may contain small quantities of spent nuclear fuel or high-level waste. Soil vault rows contain high-activity, low-level waste but no high-level waste. **Remark:** The original assumption may be erroneous.	5. Some shipments to the SDA contained waste that is similar to spent nuclear fuel or high-level waste and may exhibit some characteristics of these waste forms. **Remark:** The assumption reflects information developed since the *First Addendum* through review of waste shipment and inventory records. Waste similar to spent nuclear fuel or high-level waste may require specific attention in modeling (e.g., contaminant inventories and release and transport mechanisms) and in analyzing alternatives (e.g., safety issues related to exposure rates, potential security concerns, and interference with remedial technologies such as retrieval and ISG).
6. VOCs are assumed to be located in Pits 2, 4, 5, 6, 9, and 10 only based on information in the Historical Data Task report.	6. The majority of the VOCs are buried in Pits 2, 4, 5, 6, 9, and 10. (This assumption may change based on new spatial distribution information and updates to CIDRA.) **Remark:** The assumption was revised for clarity and to acknowledge that further research will be conducted that may justify revision.	6. The majority of VOCs are buried in Pits 4, 5, 6, 9, and 10. **Remark:** Pit 2 was eliminated based on a 2001 soil gas survey over most of Pit 2 (Housley, Sondrup, and Varvel 2002).
7. No groundwater treatment processes or technologies will be evaluated in this FS. The OCVZ Project is responsible for correcting any groundwater problems involving VOCs. Non-VOC groundwater contamination is included in the scope of OU 7-13/14, but, at this time, it is assumed that non-VOC groundwater contamination will not be a high enough risk to warrant remediation.	7. Remediation of the buried waste and contaminated soil down to the first basalt interface beneath the SDA will adequately address possible future risks to groundwater. Remediation of groundwater and the vadose zone below the first soil and basalt interface will not be evaluated in the WAG 7 FS. The OCVZ Project is addressing VOCs in the vadose zone and groundwater. **Remark:** The assumption was revised for clarity based on the results of the IRA (Becker et al. 1998), which showed possible future groundwater risks from non-VOC contaminants. Partial or complete removal, stabilization, and containment of the source will be evaluated for effectiveness in reducing future groundwater risk.	7. No revision. Remediation of the buried waste and contaminated soil down to the first basalt interface beneath the SDA, in conjunction with vadose zone vapor vacuum extraction under OU 7-08, will adequately address possible future risks to groundwater. Remediation of groundwater and the vadose zone below the first soil and basalt interface will not be evaluated in the OU 7-13/14 FS. The OCVZ Project is addressing VOCs in the vadose zone and groundwater.

Table 2-2. (continued).

Work Plan Assumption	*First Addendum* Assumption	*Second Addendum* Assumption
8. Capping scenarios will include designs appropriate to local SDA conditions. Capping may be a stand-alone alternative or may be included as a final step to another remediation alternative under this FS.	8. The selected remedial alternative will include a cap over all or part of the SDA. Capping scenarios will include designs appropriate to local SDA conditions, including a biotic barrier. Capping may be a stand-alone alternative or may be included as a final step to another remedial alternative under this FS. **Remark:** The assumption was revised to specify that a capping alternative will be selected and to add the biotic barrier specified in [*First Addendum*] Assumption 9.	8. No revision. The selected remedial alternative will include a cap over all or part of the SDA. Capping scenarios will include designs appropriate to local SDA conditions, including a biotic barrier. Capping may be a stand-alone alternative or may be included as a final step to another remedial alternative under this FS.
9. An in situ containment alternative will include a biotic barrier.	Delete. **Remark:** The assumption was combined with [*First Addendum*] Assumption 8.	Deleted in *First Addendum*.
10. A retrieval and ex situ treatment alternative will include a requirement for delisting all listed waste identified in the SDA.	9. Materials removed from the SDA for disposal elsewhere will be treated to meet ARARs and other ROD requirements as well as the waste acceptance criteria for the disposal facility. Materials returned to the SDA will meet remediation goals and comply with ARARs, including RCRA Subtitle D (42 USC § 6901 et seq., 1976) requirements for landfill closure. **Remark:** As written, the original assumption could be interpreted to mean that all listed waste buried in the SDA will be retrieved and delisted, regardless of its final disposition. The intent is to say that materials (waste or soil) retrieved from the SDA will be treated to meet waste acceptance criteria for on-Site or off-Site disposal or will meet remediation goals for return to the SDA and that remedial actions will satisfy ARARs. If the WIPP obtains a RCRA Part B permit, or another facility is identified for mixed waste, delisting for off-Site disposal may not be necessary.	Deleted. **Remark:** Because final ARARs have not been determined, the previous assumption was not relevant to bounding RI/FS work and presupposed a regulatory strategy that is one of many that are possible. Requirements will be specified in the ROD.

Table 2-2. (continued).

Work Plan Assumption	*First Addendum* Assumption	*Second Addendum* Assumption
11. A retrieval and ex situ treatment alternative will include meeting Subtitle D requirements for RCRA landfill closure.	Delete. **Remark:** The assumption was combined with the revision to [*First Addendum*] Assumption 10.	Deleted in *First Addendum*.
12. The remediation boundary for an in situ containment alternative is the physical perimeter of the pits and trenches plus 10% to account for uncertainty in pit and trench boundaries.	10. Cost estimates for a cap will be based on the estimated area of the waste zones plus 10% to account for uncertainty in boundary locations. **Remark:** The assumption was revised for clarity.	9. Cost estimates for a cap will be based on the known area of waste zones as defined in the PERA. **Remark:** The assumption was revised to delete the 10% area contingency because areas of waste disposal locations at the SDA are known with sufficient certainty.
13. A retrieval and ex situ treatment alternative will include remediating contaminated soil and the buried waste from the soil surface to the top of the basalt within the physical boundary of the pits and trenches plus 10% additional volume to account for uncertainty. This remediation boundary includes 10% of the overburden and excludes the remaining 90% of the overburden. The proposed remediation boundary for ex situ treatment does not include the soil between pits and trenches.	11. The bulk (90%) of the overburden and all soils between waste zones is not contaminated above preliminary remediation goals and, therefore, will not require remediation. Cost estimates and evaluations of retrieval and ex situ treatment alternatives will be based on the volume defined by multiplying the combined areas of the waste zones by the average depth to basalt excluding 90% of the overburden. An additional 10% will be added to account for uncertainty in the volume estimate. **Remark:** The assumption was revised for clarity.	10. Estimates for the amount of waste material requiring remediation and other cost elements for retrieval alternatives will be based on design assumptions for the non-time-critical removal action to retrieve waste from Pit 4. **Remark:** The basis for estimating retrieval, treatment, and disposal cost was revised.
14. The remediation boundary for an in situ treatment alternative is the same surface area as for an in situ containment alternative and includes a depth of containment to the top level of the basalt.	12. Cost estimates and evaluations of in situ treatment alternatives will be based on the combined areas of the waste zones and the average depth to basalt including the overburden. **Remark:** The assumption was revised for clarity.	11. Cost estimates and evaluations of in situ treatment alternatives will be based on combined areas of the waste zones and the average depth to basalt including the overburden provided in the PERA. **Remark:** The assumption was revised to incorporate improved estimates developed in the PERA.

Table 2-2. (continued).

Work Plan Assumption	*First Addendum* Assumption	*Second Addendum* Assumption
15. The total volume of waste buried in the SDA pits and trenches is based on historical records for waste buried in the SDA from 1952 to 1994, assumed to be [192,500 m^3] 6.8 million ft^3. This includes waste container volumes. It does not include the volume of interstitial soils.	13. The WAG 7 FS will address the same total waste volume estimates as the WAG 7 BRA (see Section 3.1.1, Assumption 8). As of 1994, the estimated waste volume is [192,500 m^3] 6.8 million ft^3, including waste container volumes and excluding interstitial soils. **Remark:** The assumption was revised for clarity and to incorporate planned updates to the CIDRA.	12. The total estimated volume of the SDA is 500,000 m^3 (18 million ft^3) (Holdren et al. 2002), including approximately 215,000 m^3 (8 million ft^3) of waste (DOE-ID 1997) and about 285,000 m^3 (10 million ft^3) of soil (i.e., interstitial soil, overburden, and underburden). The estimated RFP waste volume is 67,460 m^3 (2.4 million ft^3), with a total volume of RFP TRU waste of about 28,600 m^3 (1 million ft^3) (Zitnik et al. 2002). **Remark:** The assumption was revised to incorporate improved estimates developed in the ABRA and PERA.
16. The total volume of contaminated soil in the SDA is assumed to be [340,000 m^3] 12 million ft^3. This is based on an average depth of surficial soil to the top of the basalt layer of 3.7 m (12 ft). This includes underburden and interstitial soils but does not include overburden (assumed to be 1.8 m [6 ft] on average) or soil between pits and trenches, although it does include an additional 10% to account for some contaminated soil between pits and trenches and an additional 1.8 m (0.6 ft) depth to account for potentially contaminated overburden. This does not include the volume of waste defined in the previous assumption. For the purposes of this assumption, contaminated soil is defined as soil that will need to be remediated.	14. For costing purposes, the estimated total volume of soil contaminated above risk-based remediation goals is [340,000 m^3] 12 million ft^3. The volume estimate includes underburden and soils within the waste zones and excludes overburden and soils between the waste zones. The estimate is based on an average waste zone thickness of [3.7 m] 12 ft ([5.5 m] 18 ft from the surface to basalt minus [1.8 m] 6 ft of overburden). **Remark:** The assumption was revised for clarity. In addition, see the revision to [*First Addendum*] Assumption 13.	13. For costing purposes, the total estimated volume of soil contaminated above risk-based remediation goals in the RFP TRU pits and trenches (Pits 1–6 and 9–12 and Trenches 1–10) and Pad A is 149,900 m^3 (5.3 million ft^3) (Zitnik et al. 2002). **Remark:** Volume of soil requiring treatment is an important consideration for alternatives involving full retrieval.
17. The volume of the overburden assumed uncontaminated is [227,000 m^3] 8 million ft^3.	15. For costing purposes, the estimated volume of overburden with concentrations less than risk-based remediation goals is [227,000 m^3] 8 million ft^3. **Remark:** The assumption was revised for clarity.	14. Overburden volume estimates from the PERA will be used to develop cost estimates for the full retrieval alternative. The estimated volume of overburden with concentrations less than risk-based remediation goals is 113,000 m^3 (4.0 million ft^3) for the RFP TRU pits and trenches and Pad A. **Remark:** The assumption was modified to reference the PERA.

Table 2-2. (continued).

Work Plan Assumption	*First Addendum* Assumption	*Second Addendum* Assumption
18. The volume of the soil between the pits and trenches assumed uncontaminated is [1.4 million m^3] 50 million ft^3 based on an average depth of soil of 5.5 m (18 ft).	16. Based on an average depth to basalt of [5.5 m] 18 ft and the approximate total area between waste zones, the volume of soils between waste zones with concentrations less than risk-based remediation goals is [1.4 million m^3] 50 million ft^3. **Remark:** The assumption was revised for clarity.	15. No revision. Based on an average depth to basalt of 5.5 m (18 ft) and the approximate total area between waste zones, the volume of soils between waste zones with concentrations less than risk-based remediation goals is 1.4 million m^3 (50 million ft^3).
19. A large fraction of waste containers are assumed to be degraded to the point of not providing containment of their contents; however, it is assumed that some drums with free standing liquids will be intact so that retrieval and handling equipment will need to process some drums containing potentially flammable liquids.	17. Some of the drums buried in the SDA may contain freestanding, potentially flammable liquid. **Remark:** The wording was revised so that it was stated as an assumption.	16. No Revision. Some drums buried in the SDA may contain freestanding, potentially flammable liquid.
20. The only ex situ treatment alternative that will be evaluated in this FS will be a combination of technology types demonstrated in the OU 7-10 interim action, with additional processes or process modifications to address all COCs for OU 7-13/14 that were not part of the design basis for OU 7-10 processes. Additionally, OU 7-10 processes will be examined for areas of high risk relative to OU 7-13/14 remediation. Additional FS evaluations will be conducted to identify contingencies only to the high-risk portions of OU 7-10 processes.	Delete. **Remark:** Alternative ex situ treatments will be considered in the WAG 7 FS.	Deleted in *First Addendum*.
21. Technology performance and cost data provided under the OU 7-10 contract will likely not completely address OU 7-13/14 contaminants. A practical way of addressing this issue is to assume a potential need for treatability studies that would probably include adding scope to some OU 7-10 tests. The proposed FS baseline reflects this.	Delete. **Remark:** According to the Revised Scope of Work for the WAG 7 RI/FS (LMITCO 1997), development of the WAG 7 FS is independent of the OU 7-10 interim action (DOE-ID 1993). Coordination of the projects is ongoing, and progress of the OU 7-10 interim action will be monitored. The interface between the two projects is discussed in Section 4.1 [*First Addendum*].	Deleted in *First Addendum*.

Table 2-2. (continued).

Work Plan Assumption	*First Addendum* Assumption	*Second Addendum* Assumption
22. The FS schedule and budget may need to be renegotiated if the OU 7-10 interim action is delayed so that critical characterization and performance data will not be available in time to support the current FS schedule. The FS schedule and budget may be modified if the OU 7-10 interim action does not meet performance or cost goals, that is, if a decision is made not to proceed with full-scale remediation of OU 7-10.	Delete. **Remark:** The OU 7-10 interim action has met with significant delays. See the revision to [*First Addendum*] Assumption 21.	Deleted in *First Addendum*.
23. It is assumed that a volume of OU 7-10 concentrated waste residuals with >10 nCi/g and not meeting LDRs will be generated and dispositioned in the OU 7-13/14 comprehensive RI/FS.	Delete. **Remark:** The assumption was combined with the revisions to [*First Addendum*] Assumptions 29 and 31.	Deleted in *First Addendum*.
24. For cost-estimating purposes, all concentrated waste residuals from Pit 9 will be dispositioned in the OU 7-13/14 comprehensive RI/FS.	Delete. **Remark:** The assumption was combined with [*First Addendum*] Assumptions 29 and 31.	Deleted in *First Addendum*.
25. Investigations will be limited to technologies that have been successfully demonstrated at a pilot scale or greater before the start date of the OU 7-13/14 ROD (currently scheduled for February 28, 1998).	18. Alternatives considered in the WAG 7 FS will be limited to existing demonstrated technologies. Though treatability studies to demonstrate technology implementability and effectiveness may be conducted, technology development is not in the scope defined for the WAG 7 RI/FS. Emerging technologies with potential application to the SDA will be monitored. Those successfully demonstrated at a pilot scale or larger before development of the draft OU 7-13/14 ROD begins, currently scheduled for 2002, will be considered. **Remark:** The assumption was revised to add detail and correct the anticipated ROD date.	17. Alternatives considered in the WAG 7 FS will be limited to existing demonstrated technologies. Though safety analysis and bench-scale studies to demonstrate technology implementability and effectiveness may be conducted, technology development is not in the scope defined for the WAG 7 RI/FS. Only those technologies that are presented in the PERA will be considered in the FS, though emerging technologies will be monitored. **Remark:** The assumption was revised to specify bench-scale studies and to reflect the modified ROD schedule.
26. A No Action alternative will include costs for monitoring only.	19. No revision. A No Action alternative will include costs for monitoring only.	18. No revision. A No Action alternative will include costs for monitoring only.
27. The current baseline assumes the FS will be completed in-house.	Delete. **Remark:** The assumption is inappropriate.	Deleted in *First Addendum*.

Table 2-2. (continued).

Work Plan Assumption	*First Addendum* Assumption	*Second Addendum* Assumption
28. Any alternative evaluated in this FS will include constraints corresponding to coordination with ongoing operations at the SDA. Current plans at the RWMC include active low-level waste disposal operations until 2005.	20. Active low-level waste disposal operations at the SDA will continue until the year 2006. Any alternative evaluated in the WAG 7 FS will incorporate measures to accommodate ongoing operations. **Remark:** The assumption was revised for clarity and to reflect current planning for waste disposal operations.	19. Active low-level waste disposal operations at the SDA will continue until the year 2009. Any alternative evaluated in the WAG 7 FS will incorporate measures to accommodate ongoing operations. **Remark:** The assumption was revised to reflect current planning for waste disposal operations.
29. Treatment residuals for OU 7-13/14 that have greater than 100 nCi/g TRU waste will meet LDRs and the waste acceptance criteria for WIPP and will be prepared for shipment to WIPP. Temporary storage may need to be defined as part of the OU 7-13/14 comprehensive RI/FS depending on the schedule for WIPP startup and acceptance of waste. The WIPP Environmental Impact Statement does not currently allow acceptance of pre-1970 waste, but no other disposal options exist for this waste.	21. All treatment residuals for the SDA, including OU 7-10, containing transuranics in concentrations greater than 100 nCi/g eventually will be shipped to the WIPP. Waste acceptance criteria for the WIPP will be expanded to include mixed waste with TRU concentrations greater than 100 nCi/g. Waste will be placed in interim storage at the SDA until shipment to WIPP. **Remark:** The assumption was revised for clarity to include OU 7-10 and reflect updates to the WIPP waste acceptance criteria for pre-1970 waste.	20. Any waste retrieved from the SDA containing TRU concentrations greater than 100 nCi/g will be shipped to WIPP. Treatment of mixed TRU waste to RCRA LDRs is not required for disposal at WIPP. Treatment is required to solidify liquids and eliminate any RCRA characteristics. Waste will be placed in interim storage at the SDA until shipment to WIPP. **Remark:** The assumption was revised to reflect updates to WIPP waste acceptance criteria.
30. The WIPP Environmental Impact Statement will be expanded to include waste from the SDA, including OU 7-10 and the remaining pits and trenches.	Delete. **Remark:** The assumption was incorporated into the revision to [*First Addendum*] Assumption 29.	Deleted in *First Addendum*.

Table 2-2. (continued).

Work Plan Assumption	*First Addendum* Assumption	*Second Addendum* Assumption
31. Treatment residuals for OU 7-13/14 that have less than or equal to 100 nCi/g TRU waste will meet LDRs and all risk-based levels established in the OU 7-13/14 ROD. It is assumed that the RWMC waste acceptance criteria do not apply to this waste. These residuals will remain at the SDA. This assumption needs to be reviewed by RWMC operations, particularly relative to the RWMC performance assessment.	22. Treatment residuals from the SDA, including OU 7-10, containing TRU concentrations less than or equal to 50 nCi/g, will be permanently buried at the SDA. The current RWMC waste acceptance criteria (DOE-ID 1997), excluding waste with TRU concentrations greater than 10 nCi/g, will not apply to SDA treatment residuals. **Remark:** This assumption may be modified if the preliminary risk-based remediation goal of 50 nCi/g is revised. Off-Site disposal of some portion of the treatment residuals maybe required if exceptions to the RWMC waste acceptance criteria are not approved. The revision to [*First Addendum*] Assumption 10 addresses remediation goals and ARARs.	21. Treatment residuals for OU 7-13/14 will meet RCRA LDRs, RWMC waste acceptance criteria, and all risk-based levels established in the OU 7-13/14 ROD. Updates to the performance assessment and composite analysis for the RWMC will result in modifications to waste acceptance criteria such that TRU concentrations less than 100 nCi/g will be acceptable for the SDA. **Remark:** This assumption was revised to reflect forthcoming modifications to RWMC waste acceptance criteria.
	23. [New in *First Addendum*] Core samples from drilling will provide adequate soil and waste volumes and COPC distributions for conducting the bench-scale ex situ soil treatability studies.	Delete. **Remark:** Waste zone mapping, probing and probehole monitoring, and retrieval in Pit 9 are substituted for cores. The bench-scale ex situ soil treatability study was eliminated from scope.
	24. [New in *First Addendum*] Vendor and INEEL facilities necessary to conduct bench- and large-scale treatability tests and perform required analyses are available, and the appropriate approvals can be obtained.	22. Vendor and INEEL facilities necessary to conduct bench-scale studies and perform required analyses are available, and appropriate approvals can be obtained. **Remark:** Large-scale treatability tests are eliminated.
	25. [New in *First Addendum*] The AMWTF or the OU 7-10 treatment facility will provide ex situ thermal treatment of the waste and soil retrieved from the SDA.	23. The FS will address ex situ treatment and disposal of retrieved materials using design information from the Pit 4 removal action. **Remark:** Plans for construction of an incinerator at the AMWTF were cancelled. Plans to construct a thermal treatment system for the OU 7-10 Project also were cancelled.

Table 2-2. (continued).

Work Plan Assumption	*First Addendum* Assumption	*Second Addendum* Assumption
	26. [New in *First Addendum*] The technologies for ex situ treatment of waste and debris are sufficiently understood to obviate bench-scale testing. Therefore, only ex situ treatment technologies for contaminated soil will be considered for treatability studies.	24. Bench-scale tests for ex situ grouting of nitrate-bearing waste from Pad A will be conducted. Technologies for ex situ treatment of soil and other types of waste and debris are sufficiently understood to obviate bench-scale testing. **Remark:** Treatment of waste on Pad A by ex situ grouting will be considered in the FS. Because nitrate-bearing waste can adversely affect grout, available waste retrieved from Pad A will be tested.
	27. [New in *First Addendum*] The final closure of ongoing disposal operations (i.e., Pits 17–20 including the engineered soil vaults) will be evaluated and implemented under CERCLA as a component of the OU 7-13/14 remedial action.	25. No revision. Final closure of ongoing disposal operations (i.e., Pits 17–20 including engineered soil vaults) will be evaluated and implemented under CERCLA as a component of the OU 7-13/14 remedial action.
	28. [New in *First Addendum*] Remedial alternatives evaluated in the FS for addressing contaminated soils within the SDA are sufficient to address potentially contaminated soils within the TSA. **Remark:** This assumption was formulated to preclude separate evaluation of remedial alternatives for TSA soils, which may or may not warrant remedial action. Further action under CERCLA will be evaluated based on soil samples collected during RCRA closure and decontamination and dismantlement of the TSA facilities.	26. No revision. Remedial alternatives evaluated in the FS for addressing contaminated soils within the SDA are sufficient to address potentially contaminated soils within the TSA.

Table 2-2. (continued).

Work Plan Assumption	*First Addendum* Assumption	*Second Addendum* Assumption
		27. New. Development of general response actions, remedial action objectives, technology process option screening, and development of alternatives was presented in the PERA. The FS will incorporate the general response actions and remedial action objectives from the PERA. The technology process option screening will be revised to screen out in situ treatments for organic contaminant destruction or removal, such as ISTD and ISV, based on additional information.
		28. New. Assembled alternatives that will be analyzed in detail are limited to: No Action, Containment (i.e., modified RCRA Type C and evapotranspiration surface barriers), ISG, partial RTD, and full RTD. See Section 4.1.1.2 for additional details regarding these assembled alternatives.
		29. New. All assembled alternatives to be analyzed in detail, except for No Action, will include all of the following elements:[a] • Pretreatment for subsidence control (cap foundation) • Continued vapor extraction by OCVZ • Containment (i.e., surface barrier) • Long-term maintenance and monitoring • Institutional control (release for unrestricted land use is not an expected conclusion from future 5-year reviews).

Table 2-2. (continued).

Work Plan Assumption	*First Addendum* Assumption	*Second Addendum* Assumption
		30. New. Preliminary documented safety analyses and criticality safety evaluations completed for in situ thermal desorption, ISG, and ISV will be used in technology and process option evaluation and screening and to assess administrative implementability of remedial alternatives as appropriate. For RTD, hazard analysis and design will be provided by the Accelerated Retrieval Project non-time-critical removal action to retrieve waste from Pit 4.
		31. New. Bench-scale tests will be conducted using surrogate materials or retrieved waste (i.e., waste retrieved from Pit 9 by OU 7-10 and available stored waste that was retrieved from Pad A).

a. In situ thermal desorption of the source (e.g., extraction and destruction of VOCs from RFP waste in transuranic pits and trenches) was listed as a common element in the *Second Revision to the Scope of Work* (Holdren and Broomfield 2003) as indicated in the PERA (Zitnik et al. 2002). However, pretreatment for VOCs may not be necessary. The BRA and FS will incorporate results being produced by OU 7-08 and available information about materials retrieved by OU 7-10 from Pit 9 to determine pretreatment requirements for VOCs.

ABRA = *Ancillary Basis for Risk Analysis*
AMWTF = Advanced Mixed Waste Treatment Facility
ARAR = applicable or relevant and appropriate requirement
BRA = baseline risk assessment
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act
CIDRA = Contaminant Inventory Database for Risk Assessment
COC = contaminant of concern
COPC = contaminant of potential concern
FS = feasibility study
HI = hazard index
INEEL = Idaho National Engineering and Environmental Laboratory
IRA = *Interim Risk Assessment* (Becker et al. 1998)
ISG = in situ grouting
ISTD = in situ thermal desorption
ISV = in situ vitrification
LDR = land disposal restriction
MCL = maximum contaminant level
OCVZ = organic contamination in the vadose zone
OU = operable unit
PERA = *Preliminary Evaluation of Remedial Alternatives*
RCRA = Resource Conservation and Recovery Act
RFP = Rocky Flats Plant
RI/FS = remedial investigation/feasibility study
ROD = record of decision
RTD = retrieval, treatment, and disposal
RWMC = Radioactive Waste Management Complex
SDA = Subsurface Disposal Area
TRU = transuranic
TSA = Transuranic Storage Area
VOC = volatile organic compound
WAG = waste area group
WIPP = Waste Isolation Pilot Plant

Table 2-3. Evaluation of activities to satisfy 1996 *Work Plan* data gaps.

Number	1996 *Work Plan* Data Quality Objectives[a]	1996 *Work Plan* Data Needs[a]	1996 *Work Plan* Data Collection Activity[a]	Remarks from *First Addendum*	Current Status and *Second Addendum* Approach
1	Identify contaminant concentration distributions in the surficial sediments for calibration of biotic uptake models, which will be used to predict risk for all pathways except for groundwater.	Spatially and temporally distributed soil sample contaminant concentrations for COCs across the SDA.	Insufficient data are available for full quantitative evaluation to fill this gap; however, qualitative evaluation using existing data is planned. There is no site where contaminant concentration profiles can be ensured to have resulted solely from biotic uptake.	Data are still insufficient to satisfy the data need. Development of remedial alternatives for the SDA in the FS incorporates the assumption that the final remediation of the SDA will include a cap that will inhibit biotic intrusion and uptake. Therefore, additional tasks to satisfy this data gap are currently not identified.	Concentrations were developed using the DOSTOMAN biotic model to support the ecological risk assessment in the ABRA for a limited set of contaminants. For human health, qualitative evaluation of surface exposure pathways was provided. No further evaluation was required based on the assumption that final remediation of the SDA will include a surface barrier that will effectively inhibit biotic intrusion and uptake.
2	Identify interbed soil contaminant concentration distributions in the vadose zone as part of differentiating whether contaminants in the aquifer may be derived from the SDA or an upgradient source.	Spatially distributed soil sample contaminant concentrations in the 110 and 240-ft interbeds.	Existing interbed sample results are of sufficient quality and quantity to make this determination. Historical samples provide adequate spatial coverage, and statistical studies have shown early sample results to be consistent with more recent sampling results. Evaluation of plutonium geochemistry will be necessary to help explain and understand the spurious nature of actinide concentration in the 240-ft interbed. Some COCs have not been analyzed in historical sampling of the interbeds (i.e., beta emitters and highly mobile nuclides, such as C-14, Tc-99, and I-129). Sampling of perched water will address these COCs.	Existing interbed sample results are inadequate to determine upgradient groundwater concentrations or to define the nature and extent of contamination beneath the SDA. Initial results from plutonium geochemistry experiments were inconclusive, and additional experiments have been defined. It has not been determined whether the actinide concentrations in the 240 ft interbed are spurious. Perched water monitoring is in progress. Though perched water monitoring will not provide data about the distribution of contamination in the interbeds, results can be used to evaluate migration. Additional sampling of the interbeds is not planned at this time.	Interbed cores taken beneath the SDA were analyzed in 1999, and results were summarized in the nature and extent of contamination evaluation in the ABRA (Holdren et al. 2002). Interbed core sample results from 1999 identified the presence of Tc-99 and Am-241 in some interbed samples. Out of 32 samples, Pu-239 and Pu-240 were detected in one, and Pu-238 was not detected. Overall, the ABRA nature and extent evaluation found no consistent, widely dispersed, dissolved-phase contaminant plumes resulting from downward migration beneath the SDA. As such, available vadose zone data cannot be used to differentiate contributions to the aquifer from the SDA or from upgradient facilities. While no additional sampling of interbed cores is planned, interbed cores from OU 7-08 drilling in 2003 are being analyzed (Whitaker 2004).
3	Identify water contaminant concentration distributions in the vadose zone as part of differentiating whether contaminants in the aquifer may be derived from the SDA or an upgradient source.	Radionuclide and inorganic analysis of water samples from perched water and soil water where available.	Initiate a minimum 2-year perched and soil-water-sampling program starting in April 1996, given available funding. Sampling of perched water will be conducted semiannually or when water is available. Soil water will be collected quarterly. LITCO waste management currently funds this activity. A sample and analysis plan has been written, and samples are currently being collected based on water availability. The priority contaminant list given to LITCO waste management from WAG 7 includes: Am-241, H-3, Pu-238, Pu-239, Pu-240, Tc-99, chromium, cadmium, ethylenediaminetetraacetic acid, mercury, and nitrate. Samples will be analyzed for these constituents if enough water is available for analyses. Contaminants to be analyzed are primary risk drivers from preliminary scoping risk assessment, the more mobile contaminant species (i.e., H-3, nitrates, mercury, and chromium) and other contaminants that have been reported as positive detects from quarterly groundwater monitoring.	The perched water and soil-moisture-monitoring program is in progress. The monitoring network will be expanded with lysimeters near the soil vaults and within waste zones. The activity is funded by WAG 7, and the sampling is now conducted quarterly. Contaminants identified as potential risk drivers in Table 2-1 and contaminants useful for model calibration will be targeted. Changes to the priority list include removing mercury and adding C-14 and Tc-99.	Perched water and soil moisture sampling is conducted three or four times per year, and results through 2001 are summarized in Section 4 of the ABRA (Holdren et al. 2002). Monitoring will continue, using the analytical priorities list identified in Section 3.5. Results from monitoring will be incorporated in the nature and extent of contamination section of the BRA. Efforts will continue to identify vadose zone calibration targets for use in modeling.

Table 2-3. (continued).

Number	1996 *Work Plan* Data Quality Objectives[a]	1996 *Work Plan* Data Needs[a]	1996 *Work Plan* Data Collection Activity[a]	Remarks from *First Addendum*	Current Status and *Second Addendum* Approach
4	Identify contaminants present at WAG 7, contaminant concentrations, and contaminant spatial distribution.	Determine amount (mass or activity), volume, and location of contaminants.	Amount of contaminants adequately filled through HDT (LMITCO 1995b) and RPDT (LMITCO 1995c) inventories. Volume of pits and trenches has been adequately identified yielding a total disposed of volume (in combination with soil overburden thickness as determined by geophysical and historical drilling). General location of contaminants has been determined using the operating history of open pits and trenches. Specific contaminant locations will be determined should the need arise from feasibility study scoping activities.	Inconsistencies in the HDT and RPDT inventories have been identified, and the estimated disposal quantities have not been updated with actual disposal data. Volume estimates are adequate. The need to determine specific contaminant locations has been identified in FS scoping.	Inventories were updated to replace disposal projections with actual disposal data through 1999. Best-estimate inventories through 2009 have been obtained. Review of historical inventories received from Idaho National Engineering and Environmental Laboratory generators is ongoing. Disposal location information will be used in conjunction with inventories to describe contaminant distributions. Refinements to buried waste information will continue throughout development of the FS.
5	Identify contaminant concentrations in the aquifer as part of differentiating whether contaminants are derived from the SDA or an upgradient source.	Collect aquifer contaminant concentration samples to identify temporal and spatial trends for primary risk drivers from the preliminary scoping risk assessment, the more mobile contaminants, and VOCs.	Partially filled through WAG 7 quarterly groundwater monitoring, USGS groundwater monitoring, and RWMC production well monitoring. Additional evaluation of upgradient wells from RWMC for H-3 and nitrates and downgradient well evaluation for nitrates will need to be conducted for clarity of possible plume extent in relation to SDA contribution, if any. Differentiation of SDA contribution to observed aquifer contamination will be done through BRA modeling in which surficial sediment contaminant concentrations, vadose zone interbed contaminant concentrations, and vadose zone water contaminant concentrations will be used to calibrate a transport model. Comparison to predicted and observed aquifer concentrations will be used to answer whether contaminants are derived from the SDA or an upgradient source. With the exception of perched water contaminant concentration data and continued quarterly sampling of the aquifer, the existing data are believed to be sufficient. There is a lack of definitive upgradient contaminant information. For example, well M7S shows elevated VOC and H-3 concentrations in the aquifer. Installation of a single upgradient well is not thought likely to provide a definitive answer as to the source of these contaminants. In consideration of the cost of installing multiple upgradient wells to potentially address the source issue, hypothesis testing using the BRA models will be used to determine whether these contaminants are from the SDA or an upgradient source.	Analyses of tritium (H-3) and nitrate plumes were inconclusive. BRA models (i.e., models used in the IRA) could not be adequately calibrated with existing data. Therefore, the IRA model results could not be used to differentiate SDA contributions to groundwater contamination from upgradient sources. Existing data were not sufficient to differentiate upgradient contributions. Source determination was not achieved in IRA modeling.	Monitoring data from Wells M11S, M12S, M13S, M14S, and USGS-127, upgradient from the SDA, indicate that tritium observed immediately north and east of the SDA could have come from the SDA and or upgradient facilities, such as INTEC and TRA. To support a final conclusion about upgradient influence, aquifer samples were collected and analyzed to address OU 7-13/14 uncertainties and interpret probable sources (e.g., C-14, chromium, sulfate, Sr-90, and I-129). The data indicate possible upgradient sources of contamination. Monitoring data will be evaluated for potential use as model calibration targets. Focus will be on nonsorbing contaminants that migrate in the dissolved phase.

a. Information in these columns is verbatim from the *Work Plan* (Becker et al. 1996).

ABRA = *Ancillary Basis for Risk Analysis*
BRA = baseline risk assessment
COC = contaminant of concern
FS = feasibility study
HDT = Historical Data Task
INTEC = Idaho Nuclear Technology and Engineering Center
IRA = *Interim Risk Assessment* (Becker et al. 1998)
LITCO = Lockheed Idaho Technologies Company
OU = operable unit
RPDT = Recent and Projected Data Task
RWMC = Radioactive Waste Management Complex
SDA = Subsurface Disposal Area
USGS = U.S. Geological Survey
VOC = volatile organic compound
WAG = waste area group

Table 2-4. Evaluation of activities specified in the *First Addendum*.

Number	Data Need	Justification for Data Need	Strategy to Satisfy Data Need	Status and *Second Addendum* Approach
1	Revised SDA waste inventory	The CIDRA contains inconsistencies and is not up to date. Accurate waste stream information is crucial to generate defensible risk estimates and plan effective waste treatment. The IRA (Becker et al. 1998) simulation results and sample data indicate that SDA inventories in the CIDRA for some contaminants may require revision, in particular: • Inventories for VOCs from RFP and C-14 from the TRA, ANL-W, and NRF are suspect • CIDRA has not been updated since the 1993 inventories were entered into the database • VOC inventories are incorrect.	Investigate inconsistencies in CIDRA and revise as appropriate. Update CIDRA with actual disposal information as it becomes available. Interface with other programs.	CIDRA was updated with actual disposal information for 1994–1999. The Waste Management Program provided best-estimate inventories for the active LLW pits for 2000 through 2009. VOC inventory from RFP has been updated (Miller and Varvel 2001). See Section 3.3. C-14 from TRA has been updated. See Section 3.3. ANL-W, NRF, INTEC, TRA, and TAN waste inventories for fission products, activation products, and actinides are being revised. See Section 3.3. Links to the waste mapping tool are being developed. See Section 3.4.
2	Physical and chemical forms of contaminants in the SDA	Additional characterization data from within, beneath, and next to the buried waste are needed to adequately calibrate the source term and fate and transport models and evaluate potential treatment options.	Choose sample locations to maximize the likelihood of success for the retrieval of specific types of waste for BRA and FS development and minimize worker exposure, equipment contamination, and safety hazards. The avoidance of large buried objects also is desirable. Prepare a sampling and analysis plan. Drill boreholes through SDA waste zones and collect intact cores for analysis. Analyze the materials retrieved during coring. Acquire information from ANL-W analysis of sludge from TSA.	Waste and interstitial soil were collected by OU 7-10 from Pit 9 (Salomon et al. 2003). A combination of information will be substituted for information that was to be obtained through coring. Information sources include analysis of materials retrieved by OU 7-10 from Pit 9, buried waste information (shipment mapping, geophysics, and other data layers), data from waste stored at TSA, probing, and monitoring. Additional information that becomes available within the OU 7-13/14 schedule from the Pit 4 non-time-critical removal action also will be applied.

Table 2-4. (continued).

Number	Data Need	Justification for Data Need	Strategy to Satisfy Data Need	Status and *Second Addendum* Approach
3	Perched water and soil moisture monitoring data	Additional environmental sampling and monitoring data from the vadose zone are needed to assess the nature and extent of contamination and calibrate fate and transport models.	Expand the analyte lists for sampling and monitoring activities and continue the ongoing monitoring program. Install monitoring instrumentation in new boreholes within the SDA. Install monitoring instrumentation in boreholes drilled by another INEEL program near the soil vaults.	Quarterly vadose zone perched water and soil moisture monitoring continues. Nature and extent of contamination were described in the ABRA. Because detection of contaminants in the vadose zone and groundwater is sporadic, model calibration was not improved. Analyte lists for lysimeter, perched water, and soil gas samples were tailored to allow for routine analysis of some COCs and periodic analysis of other COCs and analytes. Type B probes were installed in several monitoring locations across the SDA. Instruments that are working are being monitored, and instruments that are not working are being fixed, replaced, or abandoned (see Section 3.7) Additional probes were installed near beryllium blocks in Soil Vault Row 20. See Section 3.3 and ABRA Sections 3.9, 4.6.4, and 4.6.7.

Table 2-4. (continued).

Number	Data Need	Justification for Data Need	Strategy to Satisfy Data Need	Status and *Second Addendum* Approach
4	Groundwater monitoring data	Additional environmental sampling and monitoring data from the aquifer are needed to characterize the nature and extent of contamination, calibrate fate and transport models, and discriminate SDA contributions to groundwater contamination from upgradient sources.	Construct four new upgradient groundwater-monitoring wells. Continue ongoing sampling and monitoring of groundwater.	Wells M11S, M12S, M13S, M14S, and USGS-127, upgradient from the SDA, were drilled and completed in 1998 and 1999. Monitoring data from these wells indicate that tritium observed immediately north and east of the SDA most likely came from the SDA and not from upgradient facilities. To support a final conclusion about upgradient influence, aquifer samples were collected and analyzed to address OU 7-13/14 uncertainties and interpret probable sources (e.g., C-14, chromium, sulfate, Sr-90, and I-129). The data suggest potential upgradient sources of contamination. Modeling results will be evaluated against monitoring data. Focus will be on mobile, dissolved-phase contaminants.
5	Extent of VOC contamination in TSA soils	TSA soil gas data from passive sampling in 1997 have not been evaluated to determine whether TSA soils have been contaminated by TSA operations. New active sampling data collected by the OCVZ Project also may be available, and the RCRA program may collect soil samples in the future in preparation for closure of TSA. All of these data can be used to resolve the questions remaining from the Track 1 investigation (EG&G 1993) of historical TSA releases.	Analyze newly acquired soil gas data for TSA. Coordinate characterization and remediation with the planned RCRA closure of TSA and the OCVZ Project.	Results from passive soil gas sampling performed in 1997 were largely inconclusive. Future sampling by British Nuclear Fuels will be evaluated as the facility is prepared for closure.

Table 2-4. (continued).

Number	Data Need	Justification for Data Need	Strategy to Satisfy Data Need	Status and *Second Addendum* Approach
6	Site-specific corrosion rate	The corrosion rate used in the IRA (Becker et al. 1998) is highly uncertain. Developing a site-specific corrosion rate will greatly improve the quality of the BRA estimates.	Acquire site-specific corrosion rates from experiments conducted by another INEEL program. Evaluate materials retrieved during borehole drilling and analysis of cores to determine whether corrosion data can be inferred.	The corrosion rate used in the IRA was modified in the ABRA to adopt data from coupon studies modified to account for effects of magnesium chloride. If available and appropriate, site-specific corrosion rates from other programs will be incorporated into fate and transport modeling. Materials retrieved from Pit 9 will be visually examined to qualitatively assess corrosion. Borehole drilling within the waste zone will not be performed, so other materials will not be available to evaluate.
7	Carbon-14 phase relationships	C-14 is a COPC identified in the IRA. Because phase partitioning was not simulated in the IRA, the mass of C-14 vented to the atmosphere was not considered. Defining the C-14 phase relationships is required to support more accurate predictions in the BRA.	Acquire appropriate C-14 phase partitioning data from column tests conducted by another INEEL program.	Data from the column study became available after the ABRA. C-14 was simulated as if it moved strictly as a dissolved-phase contaminant in the ABRA. For fate and transport modeling, C-14 will be simulated as dual phase with vapor-phase and dissolved-phase partitions (see Section 4.7).
8	Site-specific actinide migration rates	Site-specific data for actinide migration rates are required to improve predictive modeling results. The IRA modeling did not replicate actinide concentrations detected in the vadose zone and groundwater.	Develop site-specific actinide migration rates through laboratory column studies.	A series of batch and column tests were conducted at Clemson University using SDA interbed samples. Results showed a very small (<<1%) mobile fraction of plutonium and americium. Mobile fractions of plutonium were included in sensitivity simulations for the ABRA. Site-specific sorption isotherms for uranium and neptunium were developed, and substantiated that conservative values were used in the ABRA.

Table 2-4. (continued).

Number	Data Need	Justification for Data Need	Strategy to Satisfy Data Need	Status and *Second Addendum* Approach
				Plutonium mobility simulations will be based on Batcheller and Redden (2004). A best-estimate mobile fraction of 3.7% of total RFP plutonium at the time of disposal will be simulated as mobile (colloidal or colloid-sized) using a K_d of 0 mL/g for source release and transport of this fraction to the B-C interbed. The interbed effectively retards the mobile fraction, and subsequent transport will be simulated with a K_d of 2,500 mL/g. The remaining 96.3% of RFP plutonium waste and plutonium-contaminated waste received from other generators will be simulated with a sediment K_d of 2,500 mL/g. Only Pu-239 and Pu-240 from RFP will be evaluated for facilitated transport. A mobile fraction for Pu-238 will not be modeled because Pu-238 comprises a small fraction (about 3%) of total plutonium in the SDA.
9	Waste-specific resin release rate	The resin release rate used in the IRA is highly uncertain. Two COPCs, C-14 and Tc-99, are known constituents of resins buried in the SDA. Developing site-specific resin release rates will greatly improve the quality of the BRA estimates.	Acquire appropriate resin release rates from another INEEL program.	Inventory investigations show resins are not significant contributors; thus, further evaluation is not warranted. (See ABRA Table 5-3, which shows 1.6% of C-14, and none of the Tc-99 is in resins.)
10	Refined risk estimates	COPCs were identified for the RI/BRA and FS based on the contaminant screening presented in the IRA. Results from studies identified in the *Work Plan* addendum could significantly affect the risk results and influence the issues that should be addressed in the development of the RI/BRA and the FS.	Refine IRA risk estimates as data become available to restrict the focus of the BRA and FS to issues and contaminants that will influence remedial decisions.	Risk estimates were refined and COCs were identified in the ABRA. Further refinement is planned for VOC risk estimates and for radiological contaminants that can partition into the gaseous phase, such as C-14.

Table 2-4. (continued).

Number	Data Need	Justification for Data Need	Strategy to Satisfy Data Need	Status and *Second Addendum* Approach
11	Degree of sensitivity and uncertainty associated with select IRA results	Sensitivity and uncertainty analyses are required to focus BRA development and mimic implementation of remedial alternatives to direct the FS.	Perform initial sensitivity analyses based on IRA results to mimic select remedial alternatives. Use the sensitivity analyses and refined risk estimates to determine whether secondary sensitivity analyses should be completed to support further BRA and FS development.	Sensitivity was assessed in the ABRA. Five sets of sensitivity model runs for the RI/BRA will address upper-bound inventory, upper-bound infiltration, reduced background infiltration, and non-time-critical removal actions. For the FS, two sets of runs are defined: one to address surface barrier infiltration and one to evaluate full retrieval with no cap. An upper-bound release rate for in situ grouting will be evaluated based on flux from the source term into the vadose zone. See Appendix A for more details on RI/BRA and FS sensitivity analysis.
12	Methodology for PRA	PRA techniques will be implemented to quantify the uncertainties associated with the BRA. However, PRA can be time consuming and expensive when many iterations of resource-intensive models, such as the TETRAD fate and transport simulator used in the IRA, are required. Developing and testing methodology using less resource-intensive models, such as DOSTOMAN, will greatly reduce the time and costs associated with preparing for the PRA, which cannot be completed until results are available from the BRA.	Develop distributions for parameters that are both highly sensitive and highly uncertain, or highly sensitive and highly variable. Develop and test the PRA methodology.	Probabilistic techniques will not be applied. Instead, sensitivity analyses specified above (see Number 11) will be used to qualitatively assess uncertainty.

ABRA = *Ancillary Basis for Risk Analysis*
ANL-W = Argonne National Laboratory-West
BRA = baseline risk assessment
CIDRA = Contaminant Inventory Database for Risk Assessment
COC = contaminant of concern
COPC = contaminant of potential concern
FS = feasibility study
INEEL = Idaho National Engineering and Environmental Laboratory
INTEC = Idaho Nuclear Technology and Engineering Center
IRA = *Interim Risk Assessment* (Becker et al. 1998)
NRF = Naval Reactors Facility
OCVZ = organic contamination in the vadose zone
OU = operable unit
PRA = probabilistic risk assessment
RCRA = Resource Conservation and Recovery Act
RFP = Rocky Flats Plant
RI/BRA = remedial investigation/baseline risk assessment
SDA = Subsurface Disposal Area
TRA = Test Reactor Area
TSA = Transuranic Storage Area
USGS = U.S. Geological Survey
VOC = volatile organic compound

3. REMEDIAL INVESTIGATION/BASELINE RISK ASSESSMENT DEVELOPMENT

This section addresses activities identified in Section 2 to develop and complete the OU 7-13/14 RI/BRA. In accordance with the OU 7-10 dispute resolution (DOE 2002), the draft RI/BRA report is identified as an additional primary document for OU 7-13/14 subject to protocols established in the FFA/CO for DEQ and EPA review. Data that are available by January 2005 will be incorporated directly into the investigation. Subsequently acquired information will be used when available to evaluate assumptions and support development of the OU 7-13/14 ROD and remedial design/remedial action (RD/RA).

Tasks in Sections 3.1–3.8 are organized under eight categories: (1) basis for the RI/BRA, (2) administrative interfaces, (3) SDA inventory, (4) characterization and monitoring, (5) waste zone mapping, (6) nature and extent of contamination updates, (7) waste zone probing, and (8) development of the RI/BRA report. Some activities meet multiple needs. Therefore, tasks described are not mutually exclusive but are components of the overall strategy for the OU 7-13/14 comprehensive RI/FS.

3.1 Basis for the Remedial Investigation/Baseline Risk Assessment

The basis for the RI/BRA is a combination of the ABRA (Holdren et al. 2002), results from VOC analysis conducted by OU 7-08, additional information to be developed as described in Sections 3-2 through 3-7, Appendix A (e.g., land-use assumptions, exposure scenarios, and modeling), and relevant information obtained from ongoing non-time-critical removal actions at the SDA. The *Second Addendum* assumptions (see Table 2-1) also provide a framework for the RI/BRA. Parts of the ABRA, which was prepared in accordance with EPA guidance (EPA 1988) for remedial investigations, will be largely duplicated in the RI/BRA. The RI/BRA will focus on the COCs identified in the ABRA and the *Second Revision to the Scope of Work* (Holdren and Broomfield 2003), as shown in Table 3-1.

The bulleted list that follows summarizes the overall approach for each section of the RI/BRA compared to the parallel section in the ABRA and revisions necessary to support development of the FS and remedial decisions for OU 7-13/14.

- Section 1 Introduction—This section will be modified slightly, primarily to update information about schedule, scope, and regulatory background. Language will be tailored to fit into an RI/BRA.

- Section 2 Site Background—This section will be updated, particularly to incorporate additional information about geologic and hydrologic investigations. Most of the section requires little modification for the RI/BRA.

- Section 3 Waste Area Group 7 Description and Background—This section will be modified substantially to incorporate results from the activities described in Sections 3-2 through 3-7 of this *Second Addendum*. However, large parts of the section (e.g., operational background and summary of operable units) will require only minor modification.

- Section 4 Nature and Extent of Contamination—This section will be updated to add monitoring data that have been collected since 1998. Interpretations of the data will be revised if warranted by the additional information. Density maps for all COCs also will be added.

Table 3-1. Identification of contaminants of concern and 1,000-year peak risk estimates for a hypothetical future residential exposure scenario.

Contaminant	Note[a]	Peak Risk	Year	Peak Hazard Index	Year	Primary 1,000-Year Exposure Pathway
Ac-227		3E-06	3010[b]	NA	NA	Groundwater ingestion
Am-241	**1,3**	**3E-05**	2953	NA	NA	Soil ingestion, inhalation, external exposure, and crop ingestion
Am-243		4E-08	3010[b]	NA	NA	External exposure
C-14	**1,4**	**6E-04**	2278	NA	NA	Groundwater ingestion
Cl-36		6E-06	2110	NA	NA	Groundwater ingestion
Cs-137		5E-06	2110	NA	NA	External exposure
I-129	**1,3**	**6E-05**	2110	NA	NA	Groundwater ingestion
Nb-94	**1,3**	**8E-05**	3010[b]	NA	NA	External exposure
Np-237	**1,4**	**4E-04**	3010[b]	NA	NA	Groundwater ingestion
Pa-231		3E-06	3010[b]	NA	NA	Groundwater ingestion
Pb-210		5E-07	3010[b]	NA	NA	Soil and crop ingestion
Pu-238	**2**	**1E-09**	2286	NA	NA	Soil and crop ingestion
Pu-239	**2**	**2E-06**	3010[b]	NA	NA	Soil and crop ingestion
Pu-240	**2**	**2E-06**	3010[b]	NA	NA	Soil and crop ingestion
Ra-226		3E-06	3010[b]	NA	NA	External exposure
Sr-90	**1,4**	**1E-04**	2110	NA	NA	Crop ingestion
Tc-99	**1,4**	**4E-04**	2110	NA	NA	Groundwater ingestion and crop ingestion
Th-229		4E-07	3010[b]	NA	NA	Groundwater ingestion
Th-230		7E-07	3010[b]	NA	NA	Groundwater ingestion
Th-232		1E-09	3010[b]	NA	NA	Crop ingestion
U-233	**1,3**	**3E-05**	3010[b]	NA	NA	Groundwater ingestion
U-234	**1,4**	**2E-03**	3010[b]	NA	NA	Groundwater ingestion
U-235	**1,4**	**1E-04**	2662	NA	NA	Groundwater ingestion
U-236	**1,4**	**1E-04**	3010[b]	NA	NA	Groundwater ingestion
U-238	**1,4**	**3E-03**	3010[b]	NA	NA	Groundwater ingestion
Carbon tetrachloride	**1,5**	**2E-03**[c]	2105	**5E+01**[c]	2105	Inhalation and groundwater ingestion
Methylene chloride	**1,3**	**2E-05**[c]	2185	1E-01[c]	2185	Groundwater ingestion
Nitrates	**1,6**	NA	NA	**1E+00**	2120	Groundwater ingestion
Tetrachloroethylene	**1,6**	NA	1952	**1E+00**[c]	2137	Groundwater ingestion and dermal exposure to contaminated water

a. Notes: For toxicological risk, peak hazard index is given, and, for carcinogenic probability, peak risk is given:

1. **Green** = contaminant is identified as a human health contaminant of concern based on carcinogenic risk greater than 1E-05 or a hazard index greater than or equal to 1 contributing to a cumulative hazard index greater than 2.
2. **Brown** = plutonium isotopes are classified as special case contaminants of concern to acknowledge uncertainties about plutonium mobility in the environment and to reassure stakeholders that risk management decisions for the Subsurface Disposal Area will be fully protective.
3. **Blue** = carcinogenic risk between 1E-05 and 1E-04.
4. **Red** = carcinogenic risk greater than 1E-04.
5. **Pink** = toxicological (noncarcinogenic) hazard index greater than or equal to 1.
6. Gray = preliminary results from modeling, based on inventory corrections, indicate Cl-36 risk is 1E-05. If results are validated, Cl-36 will be identified as a contaminant of concern in accordance with Criterion 3.

b. Peak groundwater concentration does not occur before the end of the 1,000-year simulation period. Groundwater ingestion risks and hazard indexes were simulated for peak concentration occurring within 10,000 years and are presented in Holdren et al (2002).

c. Risk estimates were produced by scaling results from the *Interim Risk Assessment* (Becker et al. 1998) based on inventory updates.

- Section 5 Contaminant Fate and Transport—Portions of this section will be revised substantially. The subsection discussing VOCs will be completely replaced, and the subsection about biotic modeling will be slightly modified. New subsections will present dual-phase C-14 modeling and intrusion modeling. Source term and dissolved-phase modeling will be refined.

- Section 6 Baseline Risk Assessment—This section will be updated to adopt OU 7-08 VOC results and revised C-14 risk estimates predicated on dual-phase fate and transport analysis. Risk estimates will be adjusted for dissolved-phase contaminants based on refined modeling. The ecological risk assessment will be largely duplicated in the RI/BRA with adjustments for inventory revisions.

- Section 7 Summary and Conclusions—This section will be updated to provide a summary of information necessary to provide a basis for the FS. The table of COCs and risk estimates will be included.

3.2 Administrative Interfaces

Meeting OU 7-13/14 objectives will require administrative coordination between numerous facilities, projects, and personnel. The WAG 7 OU 7-13/14 Project is fundamentally responsible for integrating information. This section identifies key day-to-day interfaces that the OU 7-13/14 must maintain to meet objectives, which include RWMC Operations; Waste Management and Waste Generator Services; Surveillance, Monitoring, and Long-Term Operations; integration of RCRA and CERCLA programs; and interface with other WAG 7 projects (i.e., OU 7-08 OCVZ Project, OU 7-10 staged interim action, OU 7-12 Pad A, Accelerated Retrieval Non-Time-Critical Removal Action, and Beryllium Reflector Block Non-Time-Critical Removal Action).

3.2.1 Radioactive Waste Management Complex Operations

A number of processes and functions supporting OU 7-13/14 are managed by RWMC Operations. Fire protection, radiological control technicians, and various support personnel are provided by RWMC Operations. Additionally, RWMC Operations is responsible for work control processes for the RWMC area. All OU 7-13/14 work at the RWMC is implemented under an interface agreement between RWMC Operations and WAG 7. The purpose of the agreement is to ensure that all OU 7-13/14 field activities are efficiently coordinated, safely executed, and properly managed in accordance with requirements.

3.2.2 Waste Management and Waste Generator Services

Waste Management is responsible for on-going disposal activities at the RWMC Low-Level Waste Disposal Facility (i.e., Pits 17–20, including the engineered vaults, in the SDA). The operational timeframe for active, low-level waste pits at RWMC is uncertain, but current planning indicates disposal operations will continue through at least 2009. Waste Management developed and maintains a performance assessment (PA) (Case et al. 2000) and composite analysis (CA) (McCarthy et al. 2000) for the facility in accordance with DOE Order 435.1 (2001). The PA and CA are periodically updated to reflect changes in planning assumptions and to develop limits on disposal inventories in the form of waste acceptance criteria (DOE-ID 2002).

Waste Management works with generators to ensure that waste characteristics, such as material form, packaging, and documentation, adhere to waste acceptance criteria. During OU 7-13/14 characterization and bench-scale investigations, Waste Management will be called on to coordinate management of investigation-derived waste (e.g., hazardous, nonhazardous, radioactive, nonradioactive, mixed, TRU, and mixed TRU) to expedite all activities involving waste generation, storage, and disposal. Required documents will be completed and approved before any waste is generated. A variety of waste streams will be produced during characterization and bench-scale tests. Waste Management, OU 7-13/14, and RWMC Operations personnel will develop an interface to expedite waste generation planning. Ultimately, Waste Management will be responsible for requirements related to generation, treatment, and disposal of waste produced by OU 7-13/14 activities.

3.2.3 Surveillance, Monitoring, and Long-Term Stewardship Operations

All WAG 7 activities involving environmental monitoring, probing, and probe monitoring will be coordinated through Surveillance, Monitoring, and Long-Term Stewardship Operations. The Surveillance, Monitoring, and Long-Term Stewardship Operations Groundwater Monitoring Sampling Organization is responsible for monitoring completed under the FFA/CO program, including WAG groundwater and vadose zone sampling across the INEEL. This responsibility includes coordinating sampling resources and equipment to perform safe and efficient environmental monitoring. OU 7-13/14 is responsible for defining sampling requirements to meet FFA/CO milestones and other agreed-upon groundwater sampling commitments and will provide scope and schedule for each individual sampling event to Surveillance, Monitoring, and Long-Term Stewardship Operations.

3.2.4 Resource Conservation and Recovery Act-Comprehensive Environmental Response, Compensation, and Liability Act Interface

Operable Unit 7-09 is identified in the FFA/CO to address releases associated with TSA facilities. The source term being evaluated under CERCLA does not include waste stored at the TSA. This waste is being removed from the INEEL in accordance with the *Settlement Agreement* (DOE 1995). Possible secondary sources, such as contaminated soil in the TSA, will be evaluated under CERCLA.

The Track 1 investigation (EG&G 1993) was completed for the TSA releases with the determination that further evaluation was required under the OU 7-13/14 comprehensive RI/FS. Because initial TSA closure will be conducted under RCRA but final responsibility rests with CERCLA, closure activities must be coordinated to meet requirements of both programs. Coordination activities will include consultation with the RCRA program to maximize characterization resources and opportunities. In particular, RCRA sampling and analysis approaches will be designed to include characterization of soil external to the TSA facilities in the event that indications of potential release warrant this data collection. The interface also will ensure that samples collected will be of adequate quality for use under CERCLA and that target analytes are appropriately identified.

A number of facilities in the TSA are operated as RCRA-permitted or interim status facilities and eventually will be closed under RCRA. Generally, existing RCRA closure plans for these facilities contain performance standards associated with clean closure of units that involves removal of all waste and decontamination of associated structures. Presently, the TSA is managed by BNFL, Inc., Idaho, the prime subcontractor responsible for the Advanced Mixed Waste Treatment Project to retrieve, treat, and prepare stored TRU waste for shipment to WIPP. As part of the contract, requirements for closure of the facility will be decided between BNFL, Inc., Idaho and DOE Idaho in the future.

The CERCLA interface with RCRA closure planning activities may occur both before and after the OU 7-13/14 ROD is finalized, depending on closure schedules. The ROD is likely to contain contingent language to outline remedial action to address soil in the TSA that may be indicated based on post-ROD characterization results. This approach is based on the assumption that soil remediation options selected in the ROD for the SDA also will be appropriate for remediation of any soil requiring action in the TSA. Because waste stored at the TSA is similar to waste buried in the SDA, any potential soil contamination within TSA would not alter the list of COCs, RAOs, or preliminary remediation goals (PRGs) for OU 7-13/14.

3.2.5 Interface with Other Waste Area Group 7 Projects

Interfaces between OU 7-13/14 and other WAG 7 projects are managed by DOE-ID for efficiency and to ensure that requirements, issues, and actions are consistent with requirements of the OU 7-13/14 comprehensive RI/FS. Primary projects requiring interface include the OCVZ Project (OU 7-08), the OU 7-10 staged interim action, Pad A (OU 7-12), and ongoing non-time-critical removal actions to encapsulate beryllium blocks and retrieve waste from Pit 4. Key interfaces associated with each of these projects are discussed in Sections 3.2.5.1–3.2.5.3. Additional details about integrated studies are provided in Section 3.5.

Interface with other WAG 7 projects will be accomplished by several means: frequent WAG 7 leadership meetings, OU 7-13/14 Project planning, interface agreements, and personnel communication. Descriptions of various WAG 7 projects and activities that require administrative interface are identified in Sections 3.2.5.1–3.2.5.3.

3.2.5.1 Interface with Operable Unit 7-08 Organic Contamination in the Vadose Zone Project. The OCVZ ROD (DOE-ID 1994a) specified remedial action to extract and destroy organic contaminant vapors from the vadose zone beneath and within immediate vicinity of the RWMC.

The OCVZ Project monitors an extensive network of vadose zone and aquifer wells. Fifteen additional vapor monitoring and extraction wells in the vicinity of the RWMC were installed in 2003 for the following reasons: (1) some extraction wells have become plugged and are unusable, (2) some wells are located closer to the waste and will increase removal efficiency, and (3) some will help assess VOC contamination in areas of unknown but possibly unfavorable concentrations (e.g., near OU 7-10 and below the 240-ft C-D interbed). Based on monitoring results from wells installed in areas of unknown concentration, new wells may be used for extraction.

Major interface considerations for OU 7-08 and OU 7-13/14 include the following:

- Preservation of core material from new OU 7-08 well drilling
- Data integration for vapor monitoring wells
- Data integration for groundwater monitoring wells
- Integration of schedule activities with RWMC Operations
- Treatment system cost and performance data
- Revised VOC inventory estimates
- Shallow soil gas and soil flux data
- Integration of modeling resources and results.

3.2.5.2 Interface with Operable Unit 7-10, Staged Interim Action for Operable Unit 7-10. In accordance with the OU 7-10 interim action ROD (DOE-ID 1993), information on the effectiveness and cost of OU 7-10 remediation will be used for the OU 7-13/14 RI/FS. As stated in [*First*] *Revised Scope of Work* (LMITCO 1997), information provided in deliverables from the OU 7-10 interim action that are completed within the OU 7-13/14 schedule will be evaluated for use in the WAG 7 comprehensive FS. Data are currently available from implementation of *Waste Area Group 7 Analysis of*

OU 7-10 Stage II Modifications (INEEL 2001) for limited retrieval in Pit 9. The OU 7-10 Stage I program completed installation of 20 Type A probes during 1999.

The Glovebox Excavator Method Project was established for limited excavation and retrieval demonstration for Stage II. Final design was completed September 2002 (INEEL 2002). Waste excavation was completed in January 2004. Information from Stage II that will support OU 7-13/14 includes:

- Costs of implementing waste retrieval
- Details and experiences about performing work in the SDA
- Details on addressing quality and safety requirements.

Data developed within the OU 7-13/14 schedule will be used to assess retrieval in the OU 7-13/14 analysis of remedial alternatives. Subsequent information will be incorporated into the OU 7-13/14 RI/FS, proposed plan, ROD, and future RD/RA as appropriate. The Glovebox Excavator Method Project remedial action report is due July 2004. Excavated waste material and interstitial soil from Pit 9 are being characterized. Materials were provided to OU 7-13/14 for additional studies and bench-scale investigations. Some data obtained from the Glovebox Excavator Method Project, such as analysis of underburden cores, will be useful for assessing contaminant migration and for source term evaluation in OU 7-13/14 (see Section 3.5.5.5).

3.2.5.3 Interface with Operable Unit 7-12 Pad A. A soil cap with rock armor on the southern face was implemented in accordance with the Pad A ROD (DOE-ID 1994b). Construction of the cap was completed in April of 1995 (Parsons 1995). Pad A is currently managed under a postremediation operations and maintenance plan (Parsons 1995) and periodic CERCLA reviews.

Through the Pad A ROD (DOE-ID 1994b) and the 2-year review following remediation, analytical requirements for lysimeter samples under and around Pad A were established. These parameters are presented in the *Pad A Limited Action Long-Term Monitoring Plan, Operable Unit 7-12* (INEEL 1995). Because of limited sample volume obtained from lysimeters, analyte priorities must be assigned. To reflect requirements for nitrate analysis for Pad A, nitrate analysis is assigned first priority for the spring sample round each year. Uranium is an OU 7-13/14 COC, as shown in the ABRA. More than 20% of uranium in the SDA is on Pad A. Because the existing Pad A remedy is not consistent with all alternatives being considered for the entire SDA, the OU 7-13/14 ROD may mandate its removal.

3.2.5.4 Interface with the Accelerated Retrieval Project Non-Time-Critical Removal Action. Waste from a 1/2-acre area in Pit 4 is being retrieved as a non-time-critical removal action. The project focuses on retrieval of TRU waste received from RFP. An Engineering Evaluation and Cost Analysis (DOE Idaho 2004) was prepared and the public review was concluded in June 2004; an action memorandum is forthcoming. Construction has been initiated and retrieval is expected to begin by October 2004.

Data developed during the project within the OU 7-13/14 schedule will be used to assess retrieval in the OU 7-13/14 analysis of remedial alternatives. Personnel from OU 7-13/14 and the retrieval project are coordinating on conceptual design, trade studies, and development of the safety basis. If partial or full RTD is identified as a preferred alternative for the SDA, additional information developed during retrieval within the schedule for OU 7-13/14 will be incorporated into the OU 7-13/14 proposed plan, ROD, and future RD/RA. Anticipated data include detailed design, cost, schedule, safety basis, and actual performance and implementability information.

3.2.5.5 Interface with the Beryllium Reflector Block Non-Time-Critical Removal Action.

Beryllium reflector blocks buried in the SDA will be grouted as a non-time critical removal action to mitigate continuing release of C-14 from the SDA. In situ grouting is being employed to saturate soil around the beryllium blocks with a wax-based grout material, inhibiting corrosion from moisture and preventing further release of C-14 by isolating the source. An Engineering Evaluation and Cost Analysis (Lopez and Schultz 2004) was prepared, public comments were incorporated, and an Action Memorandum (DOE-ID 2004) was prepared. Construction has been initiated and grouting is expected to be complete by September 2004.

3.3 Subsurface Disposal Area Inventory and Waste Stream Data

Source term information, such as inventory and waste stream descriptions, is used to define primary input for source release modeling, fate and transport modeling, risk assessment, probing and monitoring, analysis of alternatives, safety analyses, and remedial decision-making. Previous applications of source term information (Becker et al. 1998) revealed several inconsistencies associated with radioisotope inventories from INEEL waste generators and VOC inventories from RFP. As summarized below in Section 3.3.1, review of RFP VOC inventories has been completed and questions about original mass were resolved. Additional review to resolve questions about COC inventories received from INEEL waste generators is ongoing. Revised inventory estimates will be used in the BRA and FS long-term effectiveness modeling.

3.3.1 Volatile Organic Compounds

The OCVZ Project revised estimates of VOC inventories originally disposed of in the SDA (Miller and Varvel 2001; Varvel 2001), and buried waste information have been modified accordingly to support OU 7-08 modeling and the OU 7-13/14 RI/FS. The revised carbon tetrachloride inventory (Miller and Varvel 2001) is approximately seven times more than the best estimate originally reported in the HDT (LMITCO 1995b). Based on estimated total VOC mass in Series 743 sludge of 1.0E+05 kg, estimates of trichloroethylene, tetrachloroethylene, and 1,1,1-trichloroethane in Series 743 sludge also were developed. Varvel (2001) assumed the VOC mass that was not carbon tetrachloride consisted of equal volumes of three other VOCs: tetrachloroethylene, trichlorethylene, and 1,1,1-trichloroethane. Therefore, the revised estimate for tetrachloroethylene is 9.8E+04 kg (about a factor of 3.9 more than the HDT estimate). Trichlorethylene and 1,1,1-trichloroethane inventory estimates are less than the HDT values by 26% and 21%, respectively. Varvel (2001) also investigated methylene chloride, a component of Series 741 sludge, and concluded that the inventory presented in the HDT was reasonable and appropriate.

3.3.2 Inventory Evaluation for Onsite Waste Generators

Inventory revisions for INEEL waste generators are based on disposal records, nuclear physics calculations, and information from facility experts (e.g., ANL-W and NRF personnel). The following topics are being investigated:

- Fission product inventories and waste forms
- Activation product inventories and waste forms
- Actinide isotopes inventories and waste forms
- Special waste forms (e.g., waste similar to high-level waste or spent nuclear fuel)

- Beryllium reflector blocks
- Contaminants and waste forms that could interfere with remedial action
- Contaminants and waste forms that could pose unique hazards during remedial action
- Liquid disposals.

During development of the IRA, comparisons of TRA, NRF, and ANL-W disposal records with those from similar reactor operations suggested that reported inventories for TRA were significantly overestimated and that NRF and ANL-W inventories were not complete. Inventory estimates for C-14, I-129, Tc-99, Np-237, and uranium are of particular interest because these radionuclides were identified as COCs in both the IRA (Becker et al. 1998) and the ABRA (Holdren et al. 2002). The RWMC PA and CA also identified disposal restrictions and conducted an options analysis to address some of these radionuclides.

Revisions of disposal data for TRA activation and fission products were developed (Logan 1999) and incorporated into the IRA. Gross estimates for fission products, activation products, and actinides associated with all INEEL reactor operations were incorporated in the ABRA. However, further review and refinements are being developed in cooperation with facility subject matter experts. Appropriate values will be developed, reviewed, and compared to values used in the ABRA to support the RI/BRA and FS.

In conjunction with revising INEEL reactor operation waste inventories, characteristics of various waste streams also will be reviewed to identify special waste streams that may present unique challenges for remediation. Waste similar to spent nuclear fuel or high-level waste may require specific attention in modeling (e.g., contaminant inventories and release and transport mechanisms) and in the analysis of alternatives (e.g., safety issues related to exposure rates, potential security concerns, and interference with remedial technologies such as retrieval and ISG). To reduce uncertainties associated with safety and security elements that should be evaluated in the analysis of alternatives, these inventory and waste form issues will be resolved. Modeling to support development of the RI/BRA and FS will be refined to simulate these specific waste forms.

In addition to activated metal waste streams, beryllium reflector blocks buried in the SDA are sources of C-14. Beryllium reflector blocks, originally classified as remote-handled LLW, were received from the Materials Test Reactor, Engineering Test Reactor, and Advanced Test Reactor. During efforts to characterize additional beryllium blocks for disposal at the SDA, it was discovered that impurities in the original beryllium, when subjected to neutron flux in a reactor, are transmuted to TRU radioisotopes. Two samples from stored blocks were analyzed and used in conjunction with reactor operating histories to estimate radioisotope inventories contained in beryllium blocks buried in the SDA. Results indicate the beryllium is remote-handled TRU waste (Mullen et al. 2003). These beryllium blocks are now the subject of a non-time-critical removal action (see Section 3.2.5.5). Though a generic, full retrieval alternative based on the Accelerated Retrieval Project will be evaluated (see Section 4.1), further evaluation of alternatives to address specific characteristics of this waste form will not be considered in the FS.

Except for the Acid Pit, liquid disposals were not common at the SDA, though several records indicate disposal of absorbed or partially absorbed liquid waste. Because contaminants in liquid waste may be particularly mobile, these disposals are being examined in more detail than was provided in the HDT and RPDT inventory reviews.

3.3.3 Contaminant Inventory Database for Risk Assessment

The CIDRA was updated to support development of the ABRA. Projected disposals were replaced with actual disposals for 1995–1999. To develop cumulative inventories, scaling factors were applied to reported inventories to produce estimates of small quantities of radioisotopes that are not typically reported. The scaling methodology and results were published in an RPDT supplement (Little et al. 2001).

The CIDRA is being incorporated into a buried waste information tool discussed in Section 3.4. The CIDRA will no longer be maintained as a discrete function. Inventory corrections discussed above in Sections 3.1 and 3.2 will be incorporated into buried waste information and adopted to support the RI/BRA and FS.

3.4 Buried Waste Information

Refinements and improvements to the SDA-specific mapping tool are ongoing in conjunction with inventory reviews. Waste stream locations, contaminant densities, and other data layers, such as VOC surveys, electromagnetic density surveys, probe data, depth to basalt, and disposal unit boundaries, are being mapped to evaluate candidate remedial alternatives. Ultimately, buried waste information will be used to support RD/RA. Density maps will be produced for each COC and included in the RI/BRA report to support development of the FS. Maps also will be developed for special case waste streams, such as beryllium blocks, that may require special attention because of unique characteristics that could be technically or administratively incompatible with remedial alternatives or could require special modifications. Improvements to buried waste information include data validation, migration to a new database structure, and new interface software. The new interface software will support development of a web-based tool.

Uncertainties relating to waste zone mapping are being addressed through two lines of evidence: records research and field characterization. Records research includes: (1) exhaustive records searches to reconstruct disposal histories and locations, (2) nuclear physics calculations based on mass balance and operations records to assess inventories, and (3) personnel interviews to verify operations histories and waste-generating processes. Field characterization includes: (1) multiple geophysical surveys to confirm pit and trench boundaries and provide electromagnetic data about buried waste, (2) probing to confirm the presence of radioisotopes expected for targeted shipments, and (3) soil gas surveys to confirm the presence or absence of VOC-bearing waste. Combined information from these various sources greatly increases confidence in waste zone mapping.

Detection of expected radioisotopes in Type A probe logs (Myers et al. 2003) demonstrates the success of this approach. Locations for Type A probes were initially based on disposal records. Geophysical surveys were used to refine locations, and then Type A probes were installed and logged. In every case, the logs revealed the combination of radioisotopes associated with the waste stream targeted for probing. Thus, a subset of disposal records has been corroborated. Building on success, more Type A probes were installed using the same process for choosing locations (see Section 3.7). Logging of the new probes began in August 2003 and was completed January 2004. Data from the new probes engender further confidence in waste disposal information and reduce uncertainty.

In addition, process knowledge and assay data will be used to assess uncertainty in the density maps. Available data about RFP waste stored in the TSA will be used to develop statistical descriptions of expected contaminant distributions over varying timeframes for RFP operations.

3.5 Characterization and Monitoring

Routine aquifer, vadose zone, and waste zone monitoring are being conducted four times each year. At the end of FY 2004 however, aquifer monitoring will be reduced to twice a year until one year after the OU 7-13/14 ROD is finalized. Waste zone and vadose zone monitoring will continue to be conducted four times a year until one year after the OU 7-13/14 ROD is finalized. The ROD will specify further monitoring requirements based on remedial decisions. Monitoring data are used to assess contaminant migration and interpret spatial and temporal patterns. In addition to providing data for evaluating source release into the vadose zone, contaminant migration through the vadose zone, and potential impacts to the aquifer beneath the RWMC, these data provide information to construct and evaluate models and will provide a baseline against which effectiveness of future remediation can be measured.

The network contains more than 650 sampling and monitoring locations. The RWMC monitoring network was expanded in 1999 and 2000, primarily in response to USGS recommendations (USGS 1999) to improve coverage and reduce uncertainties. The OU 7-08 OCVZ Project installed additional vapor vacuum extraction and monitoring wells and aquifer-monitoring wells in 2003. A new aquifer monitoring well also was installed in 2003 immediately south of the SDA to replace the damaged M10S aquifer monitoring well, and additional vadose zone lysimeters are being placed within the SDA.

New Type A and Type B probes were installed within the waste (see Section 3.7). Additional probing is being installed in FY 2004 to allow for further characterization in areas probed in FY 2003. Other probing areas have not been identified by DOE-ID, IDEQ, and EPA.

Lysimeters in the east end of the SDA were installed in FY 2004 in an area not covered by the existing monitoring network. The lysimeters were installed in the trench area in the east end of the SDA. According to disposal records, these trenches contain many INEEL-generated waste streams that probably contain fission- and activation-product COCs. Waste similar to spent nuclear fuel also may be present.

The ABRA contained an exhaustive evaluation of the nature and extent of contamination of OU 7-13/14 COPCs based on data collected through 2001. Evaluations are updated as additional data become available to assess developing trends, formulate recommendations about analyte priorities and modifications to the monitoring program, and support development of the RI/BRA and FS reports. Beginning with 2002 data, an annual monitoring report has been published (Olson et al. 2003; Koeppen et al. 2004). Annual monitoring reports will be published until 1 year after the ROD is finalized. Samples collected from the aquifer, vadose zone, and waste zone each monitoring period are and will continue to be analyzed for select radionuclides, anions, VOCs, and inorganics as described in Sections 3.5.1–3.5.3. These data will be provided to the agencies after each sampling event, in accordance with the FFA/CO.

3.5.1 Waste Zone and Surface Sediment Monitoring

The objective of waste zone monitoring is to improve site characterization by providing data to validate shipment locations and assess source release (Myers et al. 2003). More than 400 probes have been installed in the waste zone. Nearby surface sediments between and outside of waste zones also are monitored. The following list includes types of probes and their monitoring frequency:

- 53 suction lysimeters in the waste zone monitored quarterly
- 42 suction lysimeters in surficial sediments between and away from waste zones, monitored quarterly

- 66 tensiometers, monitored continuously with a data logger with periodic downloads
- 30 soil gas and vapor sampling ports, monitored quarterly
- 64 soil moisture resistivity probes (with a total of 95 soil moisture resistivity sensors), monitored continuously with a data logger with periodic downloads
- 10 visual probes, logged twice; further logging not planned
- 188 Type A probes for nuclear logging measurements, logged once; further logging not planned. (If new logging tools or methods are developed and available, DOE, DEQ, and EPA may reconsider if additional logging is appropriate.)

Because of limited sample volume obtained from lysimeters, analytical priorities are identified. Priority lists for lysimeter samples within the SDA probe focus areas are listed in Table 3-2. Further descriptions of focus areas are provided in the ABRA. For the Organic Sludge Focus Area, volatile organic compounds (VOC) data are of high priority, but because a vacuum is placed on the lysimeters for a week before sample collection, obtaining a usable VOC sample is not possible. Furthermore, VOC data from the vapor monitoring networks were deemed sufficient.

Table 3-2. Analytical priorities for Type B probe (i.e., waste zone) lysimeters

	Preservative	Sample Volume (mL)	Organic Sludge Focus Area	Depleted Uranium Focus Area	Americium/ Neptunium Focus Area	Enriched Uranium Focus Area	Carbon-14 Focus Area
Lysimeters	—[a]	—	743-03-L1 743-03-L2 743-08-L1 743-08-L2 743-18-L1 743-18-L2	DU-10-L1 DU-10-L2 DU-14-L1 DU-14-L2 DU-08-L1 DU-08-L2	741-08-L1 741-08-L2	Pit 5-TW1-L1 Pit 5-4-L1	SVR-12-1-L1 SVR-12-1-L2
Gamma-emitters Tc-99 Nb-94	Acid	50	1	1	1	1	1
Uranium Plutonium Am-241	Acid	50	2	2	2	2	—
Np-237	Acid	50	3	3	3	3	
C-14	None	50	4	4	4	4	2
I-129	None	50	5	5	5	5	6
H-3	None	50	6	6	6	6	3
Ni-59	Acid	500	—	—	—	—	4
Ni-63	Acid	500	—	—	—	—	5
Nitrate/nitrite	None	25	7	7	7	7	—
Metals	Acid	25	8	8	8	8	7
Appendix IX volatile organic compounds	—	—	9	9	9	9	—

a. Not applicable

From July 2001 through December 2003, only eleven Type B lysimeters had yielded a soil moisture sample from the waste zone, and the largest sample was only 20 mL. From November 2001 through December 2003, 112 bag samples and 39 canister samples were collected from the Type B vapor probes.

3.5.2 Vadose Zone Monitoring

The vadose zone consists of the unsaturated zone beneath the buried waste and above the aquifer. Routine monitoring of the vadose zone is ongoing. The vadose zone monitoring network at the RWMC was greatly expanded in 1999 and 2000 with 22 additional lysimeters. More instruments were installed in 2003 by the OCVZ Project and in 2004 by OU 7-13/14. Currently, the vadose zone network consists of the following:

- 3 perched water sampling wells above the C-D interbed
- 61 advanced tensiometers in the vadose zone
- 191 soil gas ports in the vadose zone and aquifer
- 29 suction lysimeters in B-C and C-D interbeds.

The vadose zone network is sampled quarterly. Because of limited sample volume obtained from the lysimeters, an analytical priority list has been established whereby contaminants with highest priority are targeted for analysis first. Priorities focus on groundwater COCs, and are established based on mobility of the contaminant, historical concentration levels, trends, and considerations about the analysis (e.g., sample volume necessary to achieve an adequate detection limit). The current priority list for SDA vadose zone lysimeters is shown in Table 3-3, which also identifies sample volume requirements for each contract-required detection limit. Nondestructive analyses are completed first and the sample aliquot is used again for other analyses. The priority list is reviewed periodically and updated as new information becomes available to evaluate detection limits achieved by the laboratory with sample volumes specified in the table and to determine if less volume could be used without compromising detection limits. If so, more analytes could be analyzed in future sampling campaigns. An improvement made in this *Second Addendum* was adding Tc-99 gamma spectroscopy analytes, reducing the overall volume of sample needed.

A network of advanced tensiometers in the B-C and C-D interbeds was installed in 1999-2000 and became operational in the Fall of 2000 (McElroy and Hubbell 2003). Monitoring results from this network are being used to assess the hydrological conceptual model that was implemented in ABRA flow and transport modeling. Monitoring to date has been primarily through a dry cycle, hence continued monitoring of the network is important to obtain hydrologic responses under a variety of conditions, including normal and wetter-than-normal cycles. This network also will serve as a means to demonstrate the effectiveness of remedial action to reduce infiltration inside the SDA (see Section 4.4.2).

The advanced tensiometer network complements ongoing efforts to improve sample volumes recovered from collocated suction lysimeters. The advanced tensiometer network provides an indication of whether matric potentials in interbeds are in a range where sample volumes can be maximized. Monitoring pressure response within suction lysimeters has dramatically improved the amount of water being recovered. Sampling pressure history has been used to define optimal suction pressures and durations. Using the pressure response to guide the sampling approach ensures that hydraulic contact with surrounding media is not broken by applying too much suction, drying out the connection to surrounding media, or enabling air to enter the chamber and break the vacuum.

Table 3-3. Analyte priority list for Radioactive Waste Management Complex vadose zone lysimeter and perched water samples.

Analysis Priority	Required Detection Limit (pCi/L or mg/L)	Sample Volume Required (mL)	Basis
Gamma emitters[a]	<200	50	Nondestructive analysis that provides data on several COCs
C-14	<50	50	COC, highly mobile (K_d ~5 mL/g), detected in vadose zone (perched water and soil moisture samples)
Tc-99	<15	50	COC, highly mobile (K_d ~0 mL/g), detected in vadose zone (core, soil moisture, and perched water samples)
Uranium Plutonium Am-241	<2	50	COCs (plutonium is a special-case COC [Holdren and Broomfield 2003])
I-129	<40	50	COC, highly mobile (K_d ~0.1), intermittently detected in the vadose zone (soil moisture) at levels >maximum contaminant level
Np-237	<2	50	COC, highly mobile (K_d ~8), not detected in the vadose zone but detected in the waste zone
Anions[b]	2[b]	25	COC (nitrate), detected in the vadose zone (soil moisture)
Metals[c]	Varies[c]	180	No COCs, but chromium is a potential model calibration target
H-3	<250	50	Not a COC, detected in vadose zone (perched water and soil moisture samples) at isolated locations, potential model calibration target
Ni-59	<400	50	Potential COC depending on inventory revisions, not previously monitored in the vadose zone
Ni-63	<50	50	Potential COC depending on inventory revisions, not previously monitored in the vadose zone
Cl-36	100	500	Potential COC depending on inventory revisions, not previously monitored in the vadose zone, of interest to Waste Management for the performance assessment and composite analysis

COC = contaminant of concern

a. Gamma-emitting radionuclide target list: Sb-125, Ce-144, Cs-134, Cs-137, Co-60, Eu-152, Eu-154, Eu-155, Mn-54, Nb-94, Ru-106, Ag-108m, Ag-110m, and Zn-65. In addition, the laboratory reports other gamma-emitting radionuclides detected above the sample-specific minimum detectable activity and the 2σ confidence level.

b. Anion target analyte list: bromide, chloride, fluoride, nitrate-N, nitrite-N, orthophosphate-N, and sulfate. The required detection limit is 2 mg/L for nitrate/nitrite as nitrogen. Anion analysis is assigned first priority for one quarter each year.

c. Metal target analyte list: aluminum, antimony, arsenic, barium, beryllium, cadmium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, nickel, potassium, selenium, silver, sodium, thallium, vanadium, and zinc. Detection limits vary by analyte.

3.5.3 Aquifer Monitoring

Aquifer monitoring through FY 2004 is conducted quarterly. Beginning in FY 2005, monitoring will be conducted twice per year until one year after the OU 7-13/14 ROD is finalized. Five new aquifer-monitoring wells have been added to the RWMC network since 1998, and several more are being added. Currently, the aquifer-monitoring network around the RWMC includes 23 wells. Fifteen are monitored by the INEEL, and eight are monitored by the USGS. The State of Idaho Oversight Program also samples some of the RWMC wells. The analyte list for aquifer samples from INEEL wells was recently updated to address emerging concerns about some contaminants that were not being adequately monitored. The following changes were incorporated into routine aquifer monitoring:

- Chlorine-36 will be monitored annually

- A lower detection limit of 0.10 pCi/L will be applied once each year for I-129 with 1 pCi/L routine detection limit otherwise. (To achieve the lower detection limit of 0.10 pCi/L, 8L of sample volume must be collected instead of 1L for the 1 pCi/L, which adds to sampling time, shipping requirements, and analytical costs. In May 2002, 16 8L samples were collected and analyzed to the lower detection limit and there were no detections. Therefore, the lower detection limit will be required only in the spring sampling round each year to coincide with the nitrate analyses.)

Special studies examining upgradient influences, groundwater background concentrations, and ultra low-level detection limit analyses are outlined in Section 3.5.5.

3.5.4 Tracer Studies

A tracer study by the USGS is planned to evaluate the impact of water from the spreading areas on water movement and contaminant transport beneath the SDA. Preliminary work to identify appropriate tracers will be completed by OU 7-13/14 to assist the USGS. A limited study was conducted by the USGS in 1999 (Nimmo et al. 2001) that determined water from the spreading areas migrated laterally to reach the vadose zone beneath the SDA. Additional data will be acquired to confirm and quantify the extent of additional water into vadose zone flow and transport modeling associated with WAG 7.

Water from the spreading areas could impact contaminant movement in different ways. Increased water in interbeds beneath the SDA could diminish downward migration of VOCs, resulting in higher vadose zone concentrations, but could increase rate of movement of dissolved contaminants. In both cases, additional water from the spreading areas could dilute contamination.

Tracer studies are a common means of qualitatively or quantitatively evaluating flow paths, travel times, and breakthrough curves in hydrologic systems. Hundreds of chemical, radiological, and fluorescent dye tracers can be used to mimic the behavior of water or serve as surrogates for contaminants with similar chemical properties. Tracers can be injected into groundwater, mixed into ponded water, or applied in soil surface or subsurface, in dry form or a dilute solution, in pulses or all at once, or in a variety of other ways to achieve test objectives.

Results of the USGS tracer study (Nimmo et al. 2001) suggest that some perched water beneath the SDA is derived from episodic surface water more than 1 km (0.6 mi) away; however, because the USGS applied the same kind of tracer to both Spreading Area A and Spreading Area B, it was not possible to determine if water originated west or southwest of the SDA, or both. Determining origin of the water is part of determining more accurate estimates of the extent of impact. Conservative tracers with unique chemical signatures will be selected and applied in Spreading Areas A and B by the USGS, and water samples will be collected periodically to monitor the advance of migrating water. These measurements, in combination with measurements from the advanced tensiometer network, will support inverse modeling to quantify the impact.

The spreading area tracer test depends on sufficient accumulations of water. Spring is typically optimal, but the past several years have been relatively dry and water has not accumulated in the spreading areas. Nonetheless, preliminary work to identify appropriate tracers will be completed by OU 7-13/14 to assist the USGS in mobilizing a spreading area tracer test at the earliest opportunity.

3.5.5 Collaborative Projects and Special Studies

Several ongoing projects generate data that are useful for the OU 7-13/14 RI/BRA and FS. Collaborative partners and administrative interfaces with those partners were identified in Section 3.2. Unlike routine monitoring described in Sections 3.5.1–3.5.3, most collaborative projects are directed toward a particular topic. Data from these studies are generally used by OU 7-13/14 to improve site characterization, to assess simulations, and to assess effects of waste streams on the surrounding environment. Special studies supporting RI/BRA and FS development are outlined below in Sections 3.5.5.1–3.5.5.6.

3.5.5.1 Corrosion Coupon Studies with Waste Management. OU 7-13/14 and Waste Management collaborated to develop site-specific corrosion rates to support the CERCLA assessment of WAG 7 and the maintenance plan for the PA and CA. Several sets of metal coupons were buried in an earthen berm just outside of the SDA. The first set was retrieved and analyzed by Waste Management in 1999 (Mizia et al. 2000). The second set was retrieved and analyzed by OU 7-13/14 in 2000 (Adler-Flitton et al. 2001), and the third effort was funded by Waste Management in 2003 (a report is forthcoming). Further participation by OU 7-13/14 is not planned. Corrosion coupon data provide corrosion rates to parameterize source release modeling. Any future information gathered within the RI/BRA and FS production schedule will be used by OU 7-13/14.

3.5.5.2 Carbon-14 and Tritium Studies with Waste Management. Waste Management monitors C-14 and H-3 released from activated metal and beryllium block disposals in Soil Vault Row 20 using shallow buried vapor ports. OU 7-13/14 has installed a suite of Type B probes near the same beryllium block monitoring location. The OU 7-13/14 instruments include:

- Four soil vapor probes to collect C-14 and H-3 data
- Three soil moisture probes to assess water content
- Tensiometer probes for soil moisture pressure data.

The OU 7-13/14 instruments are next to existing Waste Management monitoring stations and collect both vapor and soil moisture samples. Samples are analyzed for C-14 and H-3. Data will be used to select parameters for source release and hydrologic transport models. In addition to these instruments, two lysimeters are in this same area at 2 and 6 m (6.5 and 19.5 ft) deep. Samples from lysimeters are collected periodically and analyzed for H-3 and C-14.

Ongoing collaborative work between OU 7-13/14 and Waste Management include:

- Evaluating C-14 and H-3 sampling methods
- Defining spatial and temporal patterns associated with H-3 in the vadose zone near buried beryllium blocks
- Determining if high and increasing H-3 concentrations in soil moisture samples from lysimeters at Well W06 originate in beryllium blocks buried in Soil Vault Row 20, which is 150 ft away.

Tritium and C-14 are dual-phase contaminants. The ABRA assessed only dissolved-phase characteristics. Therefore, modeling for the RI/BRA and FS will include dual-phase transport to assess the effects of vapor-phase transport on simulated aquifer concentrations. Improved source release information will be applied to support model development, especially for C-14, which is identified in the ABRA as a near-term risk driver. Though tritium is not a COC, it is a good model calibration target because it is easily measured and routinely detected. Therefore, tritium data also will be used for calibrating models.

3.5.5.3 Active Pit Monitoring Data from Waste Management. Waste Management has installed soil moisture and other instrumentation along the faces of the active disposal pits (i.e., the contiguous Pits 17–20) before covering them during the past 5 years. The oldest monitoring stations, which are now buried within the filled portion of the active pit, have neutron access tubes, lysimeters, and gas ports. More recent stations have these same instruments, plus time-domain reflectometry and advanced tensiometers. Data have not yet been collected from any of the monitoring stations in the active LLW pit, though Waste Management plans to collect and analyze soil moisture and soil gas data in the future.

Presently, hardware (e.g., tubing) for soil moisture instrumentation has been installed in five locations across two faces within active pits. As the face advances forward with new disposals, a new set of four to five locations across the face will be installed roughly 50–100 ft from the previous face. Beginning in 2003, Waste Management began installing instruments along prepared faces and will collect soil moisture samples from suction lysimeters. Samples will be analyzed for up to six radionuclides of interest to the Waste Management performance assessment (Case et al. 2000) for the disposal operation. Depending on sample volume, C-14, I-129, Np-237, U-234, U-238, and Cl-36 are target analytes. Moisture content and soil moisture pressure data also will be collected to evaluate moisture infiltration rates at active LLW pits and to compare measured infiltration rates to rates used in performance assessment modeling (Case et al. 2000).

Data from LLW pit monitoring may be used by OU 7-13/14 to corroborate source release rates associated with the waste stream. OU 7-13/14 will assimilate and apply data collected by Waste Management made available within the RI/FS schedule. These data probably also will be useful during development of the ROD and implementation of RD/RA and, therefore, will be incorporated in OU 7-13/14 monitoring reports.

3.5.5.4 Evaluation of Upgradient Influences in the Aquifer. In order to assess the impact of SDA waste on the aquifer and to calibrate source release and flow and transport models for the FS, it is necessary to establish background aquifer concentrations just upgradient of the SDA. Analysis in the ABRA concluded that contaminants from TRA and Idaho Nuclear Technology and Engineering Center (INTEC) do not impact aquifer quality beneath the SDA, but data from a special background study were not available. The *Interim Report for the Plutonium Aquifer Background Study* (Roback 2003) indicates that the appropriate background concentration for plutonium in the aquifer is "non-detect." Aquifer samples were analyzed using thermal ionization mass spectrometry, which provides ultra-low detection limits. Results are now available from samples collected throughout the INEEL, including wells near the SDA, TAN, and just south of the INEEL boundary. Only one in 15 samples contained detectable plutonium. Plutonium data from this study will be used to identify an appropriate background value for plutonium in the aquifer. Uranium ratios (e.g., U-234:U-238) will be used to evaluate flow directions and to determine if the aquifer beneath the RWMC is influenced by upgradient sources. If so, it will be necessary to consider combined plumes in FS simulations and later modeling efforts.

Collaboration with TRA and INTEC will continue to determine if groundwater downgradient from these facilities has unique chemical signatures. The RWMC aquifer wells will be sampled and analyzed for the same contaminants. Hypotheses being investigated are that TRA has a unique signature of chromium and sulfates and that INTEC has a unique signature of chlorides, Sr-90, and I-129. In 2002, RWMC aquifer samples were analyzed for I-129 at extremely low detection limits (<0.05 pCi/L), and I-129 was not detected, suggesting that there was no impact on RWMC water quality from INTEC. In a one-time event in April 2003, wells at TRA and INTEC were analyzed for C-14, I-129, cations, and anions specifically to support WAG 7. These data will be used to assess cumulative impacts.

3.5.5.5 Operable Unit 7-10 Waste Characterization. Samples from Pit 9 were collected and are being analyzed. Data from waste, interstitial soil, and underburden samples will be used by OU 7-13/14 to qualitatively assess source release parameters and other FS issues using information from a single, limited area within the SDA. Responsibilities for managing the samples are subdivided between OU 7-10 and OU 7-13/14.

The OU 7-10 Glovebox Excavator Method Project conducted analysis under the *Field Sampling Plan for the OU 7-10 Glovebox Excavator Method Project* (Salomon et al. 2003). Samples were biased grab samples of sludge, interstitial soil, and underburden soil identified by observation. Analyses target the following:

- Organics, polychlorinated biphenyls, metals, and nitrates in waste
- Nitrates in nitrate-bearing waste streams such as Series 745 sludge
- Polychlorinated biphenyls in sludge
- Cyanide in pellets
- Contaminants in Series 743 sludge samples
- Contaminants in interstitial soil and underburden.

A portion of the waste and interstitial soil was homogenized and analyzed under the OU 7-10 *Field Sampling Plan* (Salomon et al. 2003) and then transferred to OU 7-13/14 for bench-scale tests. The objectives and other information about bench-scale testing are presented in Section 4.3.2.

Additional analysis conducted by OU 7-13/14 is focusing on determining total actinide concentrations in soil and waste media and characterizing mineralogy, surface chemistry, and selected chemical and physical properties. Unaltered waste zone materials were transferred by OU 7-10 to OU 7-13/14 for testing. A test plan was prepared for these studies (Groenewold, Fox, and Hull 2003). The test plan includes tentative plans beyond the enforceable schedule for OU 7-13/14 that may or may not be funded. Tentative plans include column studies to evaluate the presence of highly mobile fractions of actinides and to assess the effects of colloids and organoactinide complexes on actual soil and waste samples. See Table 3-4 for a summary of the test plan objectives, data uses, and analytical methods.

3.5.5.6 Column Studies. An ongoing experiment, currently funded by the EM-50 Environmental Systems Research and Analysis, is being conducted to assess mechanisms of migration of two risk drivers identified in the ABRA: C-14 and uranium. A 4-m-long column, 1-m diameter, has been constructed in a laboratory to simulate the waste zone at the SDA. The column has been filled and has had a small water flux applied at its surface and a vacuum applied at the bottom for enough time to establish steady-state unsaturated conditions throughout the column. The top of the column has atmospheric pressure conditions, which will allow exchange of gaseous-phase contaminants. Beginning in August 2002, a C-14 tracer was injected with a CO_2 gas about a third of the distance down from the top of the column. Partitioning between gaseous, aqueous, and sorbed phases is being monitored, as are C-14 fluxes with ambient, infiltrating water out the bottom of the column and out the top of the column by way of gaseous diffusion. Vapor-phase TETRAD simulations will be calibrated to this column data set, which will provide partition coefficients for a two-phase simulation of C-14 at the SDA.

Table 3-4. Summary of tasks, objectives, and data uses for sample material derived from the OU 7-10 Glovebox Excavator Method Project.

Task	Objectives	Data Uses	Test Method
Determine total actinide inventory and concentration	These data are necessary to identify actinides present in different media and to determine their concentrations.	These data will provide the baseline information on actinide concentration critical for mass balance estimation during actinide speciation and mobility relative to waste materials and soil.	Total actinide content will be measured in all waste media and soil. Subsamples will be completely dissolved and the resulting solution analyzed using multi-element ICP–MS.
Characterization of sample mineralogy, surface chemistry, and selected chemical and physical properties	These data are necessary to evaluate conditions under which TRU elements will be released from interstitial soil and waste media.	These data are important in understanding the actinide-release behavior for assessing risk, evaluating remediation options, and assessing potential unintended consequences resulting from treatment options that might result in alterations in the pH, Eh, transition metal, or organic content of the waste-bearing region.	Leach test under remediation scenarios including high pH, low pH, reducing conditions, oxidizing conditions, and high salt content. Soil mineralogy will be determined by conventional x-ray diffraction techniques. Surface chemistry will be evaluated using SIMS.
Tentatively planned column studies	This task will evaluate mobility of actinides.	These experiments will use a variety of actinide species to evaluate mobility of actinides.	Analyses will use ICP-MS.
Tentatively planned evaluations of the influence of colloids and organoactinide complexes in mobilizing small fractions of TRU metal contaminants	This task will determine whether organic ligands or submicron particles are causing fast transport for a small fraction of the actinide metals.	This task will determine whether organic ligands or submicron particles are causing fast transport for a small fraction of the actinide metals. These data are needed to support both the risk assessment and feasibility study.	Colloids will be suspended in low ionic-strength water followed by separation using either filtration or centrifugation. Colloids will be dissolved and analyzed using ICP–MS for actinide content. In addition, colloids will be analyzed using microscopy, surface analysis (i.e., SIMS), x-ray diffraction, and in situ laser scattering. Organoactinide complexes will be separated using selective extraction and chromatographic techniques. Complexes will be analyzed using electrospray ionization mass spectrometry.

ICP-MS = inductively coupled plasma-mass spectrometry
SIMS = secondary ion mass spectrometry
TRU = transuranic

Other tracers are being input at the same location as the CO_2 C-14 tracer. A dissolved uranium salt is being injected to observe uranium movement. Because of higher sorption of uranium, mobility results will take longer to obtain than for the C-14 experiment. The experiment is anticipated to have some uranium mobility results beginning in FY 2004. Funding for the project is uncertain. If funding continues, results will be available in a timeframe to assess mobility parameters used in FS modeling in the OU 7-13/14 ROD.

3.6 Nature and Extent of Contamination Updates

The nature and extent of contamination in the aquifer beneath the RWMC and in the SDA vadose zone were evaluated in the ABRA with data collected and compiled from sampling and analysis investigations conducted at the RWMC between 1971 and the second quarter of 2001. Monitoring results from all sampling of the aquifer, vadose zone, and waste zone will be reviewed, evaluated for trends, and reported with transmittals of limitations and validation reports. Updated information will be provided in annual monitoring reports and the RI/BRA.

Quarterly aquifer and lysimeter sampling has continued since the ABRA. Some radionuclides, VOCs, and nitrates were detected in aquifer samples. These detections were consistent with previous detections and trends. Vadose zone lysimeter samples collected from the area around Pit 5, the Pad A area, and the west end of the SDA continue to exhibit uranium concentrations that are much greater than local soil moisture background levels and risk-based concentrations; some lysimeters continue to exhibit increasing trends.

Soil moisture samples also were obtained from waste zone lysimeters located in the Americium/Neptunium Focus Area (Series 741), the Organic Sludge Focus Area (Series 743), the Depleted Uranium Focus Area, and the Activated Metal (C-14) Focus Area. Unfortunately, sample volumes obtained from waste zone lysimeters limited analyses to only a few radionuclides. Neptunium-237, Pu-239, Pu-240, and uranium isotopes were detected in waste zone soil-moisture samples collected from the Americium/Neptunium Focus Area (Series 741).

3.7 Waste Zone Probing

Understanding the extent of contamination within the buried waste at the SDA has been a key WAG 7 objective (Becker et al. 1996; DOE-ID 1998). Information regarding condition of the buried waste is instrumental in estimating current and future cumulative risk to human health and the environment posed by contaminants contained in the buried waste along with supporting the FS development. Earlier documents (Becker et al. 1996; DOE-ID 1998) identified the following specific data needs from the buried waste:

- Determine source term inventory
- Determine nature and extent of contamination
- Determine physical and chemical waste forms of contaminants
- Determine site-specific transport properties
- Identify or verify contaminants.

Originally, these data were to be acquired by OU 7-10 excavation and waste retrieval (DOE-ID 1993). Because of delays in the OU 7-10 Project, OU 7-13/14 began planning to collect up to 20 buried waste cores from the SDA using modified drilling and coring techniques (DOE-ID 1998).

However, during the evaluation of drilling methods, it was determined to be safer and more cost effective to install sealed probes to collect data and monitor the buried waste than to attempt a one-time effort to collect a limited number of waste cores (INEEL 2000). Instead of 20 cores, hundreds of probes were installed by OU 7-13/14 to interrogate a larger volume of the buried waste, and physical samples were collected by the OU 7-10 Glovebox Excavator Method Project (Holdren and Broomfield 2003).

The original probehole installation plan identified target areas for probing. Since publication of that document, probe locations have been revised both to reflect additional disposal information, geophysical data, and sampling data, and to incorporate technological improvements in probe installation and placement developed by OU 7-10 (Becker et al. 1999). Two probe designs, Type A and Type B, are used to interrogate the waste zone.

3.7.1 Type A Probes and Geophysical Data

Type A probes are sealed pipes that are sonically driven through the SDA cover soil and waste (Holdren et al. 2002). The probes are engineered to prevent internal contamination and potential worker exposure during installation. The probes are designed to allow nuclear logging tools to be lowered through a sealed pipe to gather indirect measurements of contaminants and moisture content within the soil cover and waste zone. The intent is to use probing to determine extent of the waste, evaluate commingling of the waste, and verify disposal locations.

Types of measurements collected from Type A probes include:

- Passive neutron log
- Passive gamma-ray log
- Moisture log
- N-gamma log
- Azimuthal surveys (selected probes only).

One hundred forty Type A probes were installed in the SDA between December 1999 and July 2001 (Holdren et al. 2002). An additional 48 Type A probes were installed between June 2003 and December 2003. Nuclear logging instruments were lowered into Type A probes to gather information on the overburden soil, waste zone, and underburden soil. Pertinent information obtained includes thickness of each layer, relative moisture, and presence of target radionuclides (Holdren et al. 2002). In addition, chlorine that correlated to known or suspected chlorine-bearing waste was detected (e.g., VOCs, personal protective equipment, or plastic). Type A data were then used to select locations for the Type B probes.

3.7.2 Type B Instrumented Probes

Type B probes also are sonically driven through the SDA cover soil and waste. Type B probes are equipped with instruments that allow long-term monitoring for moisture and contaminant release within the buried waste zone.

Table 3-5 identifies and details instrumentation for Type B probes. Type B instrumented probes include:

- Visual probes
- Tensiometer probes

- Moisture probes
- Lysimeter probes
- Soil vapor probes.

Table 3-5. Type B probe instruments.

Type B Probe Type	Purpose and Design
Visual probe	Allows visual logging devices (i.e., cameras) to be lowered down through chemical-resistant polycarbonite tubes for numerous visual confirmations of the environment in and beneath the waste zone. Still and video images provide observations about the physical nature of the buried waste (e.g., void space and dense mass) used to interpret logging responses from various geophysical tools. Visual inspection of the tubes and their integrity allows the unique opportunity to monitor status of the tubes and plan corrective action or abandonment in place, should they appear to be approaching failure.
Tensiometer	Measures matric potential (pressure head) of a porous medium under unsaturated or saturated conditions. Matric potential is used to calculate hydraulic gradients, determine direction of soil water movement in the vadose zone, and calculate the rate of flow given hydraulic conductivity of the materials. The push tensiometer is a long stainless steel cylindrical tube with a porous stainless steel section connected to a drive point at the bottom for penetration through soil and waste. A pressure transducer is sealed into the lower reservoir, which is in hydraulic contact with surrounding media by way of a porous steel cup. Once installed, water is poured down an access tube into the reservoir. A pressure transducer is lowered down the access tube and sealed in place with a graduated stopper above the water reservoir. The tensiometer is a sealed unit to eliminate any potential pathways for movement of contamination to the surface.
Lysimeter	Collects soil water under either saturated or unsaturated conditions. To collect water, a partial vacuum is applied on the porous section of the lysimeter (porous stainless steel with a 0.2-micron pore size) that is in contact with the soil, and soil water is drawn into the lysimeter body. Water is removed from the suction lysimeter by applying positive pressure, which pushes collected water up a tube to the surface and into a sample container. Amount of water collected and duration of collection depend on available soil moisture, soil water potential, conductivity of porous material in the lysimeter, and the vacuum applied. For OU 7-13/14, the push suction lysimeter will be approximately 5 cm (2 in.) in diameter. The outside portion will be the same as the push tensiometer and will consist of a long cylindrical tube with a porous stainless steel section attached to a drive point at the bottom for penetration through soil and waste. A polyvinyl chloride or stainless steel pipe connects to the porous steel section and provides a conduit and protection for air and water lines that extend to the surface. The water line extends from the bottom of the lysimeter point to the surface. The air line is above the water reservoir and also extends to the surface.

Table 3-5. (continued).

Type B Probe Type	Purpose and Design
	To operate the lysimeter, the water line is clamped off and a vacuum is applied to the lysimeter by way of the air line, which is then also clamped off. The lysimeter collects soil water, decreasing the vacuum as water moves into the reservoir.
Moisture probe	Indirectly measures moisture content of soil by using the relationship between the soil dielectric constant and the moisture content. Soil moisture content is determined by measuring the frequency shift of a high frequency excitation signal as it passes through soil. The probe also measures electrical contrasts between different geologic media, which can be used to profile resistivity.
	The soil moisture probe module is attached behind the drive point. Soil moisture electrodes are included as one of the sections of casing above the conical tip. Multiple moisture probes can be attached to a single probe. Depths of the instruments are planned and assembled before being driven into the ground. Assembly is pushed from ground surface to refusal so that the instruments are at planned depths.
	Soil moisture also will be measured during Type A probe logging. Measurements collected will be important to guide placement of the instrumented probes. The advantage of and necessity for instrumented soil moisture probes is to provide continuous monitoring of soil moisture. Data are stored on data loggers for later interpretation.
Vapor port	Allows collection of liquid samples or soil gas through a small porous section of a rod attached directly behind a drive tip.
	The WAG 7 project will employ the Conesipper® probe, manufactured by Applied Research Associates, Inc. The probe is pushed into place and can be left as a permanent installation. Soil gas samples are transported to ground surface through tubing inside the rod by applying a vacuum to the tube.

Type B probes are selected and installed based on data needs, results of the Type A probe information, and other inventory or sample data. The intent is to collect discrete moisture and soil vapor samples from the waste in an attempt to understand the release of contaminants from the waste zone and to monitor moisture movement throughout the SDA. More than 175 Type B instrumented probes were installed from May 2001 through June 2002 at several focus areas to gain more information on different waste forms and their risk to human health and the environment (Holdren et al. 2002). Type A and visual probes were installed in Pit 9 to further investigate different waste forms of plutonium-bearing waste, including graphite molds, air filters, and sludge. Type A and various Type B probes were installed in Pits 4 and 10 to investigate VOC-bearing 743 sludge, Am-241/Np-237-bearing 741 sludge, and depleted uranium. Type A probes and various Type B probes also were installed near an enriched uranium source in Pit 5, an activated metal source of C-14 in Soil Vault Row 17, and a beryllium reflector block disposal location (a source of C-14) in Soil Vault Row 20.

In 2003, more Type A and Type B probes were installed to investigate additional areas of waste disposal within the SDA to gain more information on the risk to human health and the environment (Myers 2003). A total of 48 Type A probes were installed. Type A probes were placed near waste similar to spent nuclear fuel, and disposals containing plutonium, liquid waste, or uranium (Table 3-6) (Figure 3-1). In addition, Type A probes also were installed in Pits 2, 6, and 10 at locations that are expected to have elevated levels of plutonium, as indicated from disposal records. Eighteen Type B

Table 3-6. Summary of FY 2003 and 2004 probing.

Area	Location	Target	Objective	Type A[a] Probes (yes/no)	Type A[a] Probes Installed June thru September 2003		Type A Probes Installed October thru December 2003		Proposed Network Additions: Type B[b] Lysimeter	Proposed Network Additions: Soil Moisture and Resistivity	Proposed Locations
1a	West end of Trench 3 near well W23; analytical data indicate uranium in vadose zone	Uranium waste	Investigate uranium mobility	Yes—Confirm location for Type B probes	Four probes installed—No enriched uranium was observed; high Cs-137 detected	4	Azimuthal survey	0	2	—	One lysimeter on east side of W23 at refusal (about 22 ft) One lysimeter on south side of probe T3-EU-02 (15 feet deep)
1b	Trench 47, eight NRF shipments of waste similar to spent nuclear fuel in 23-m (75-ft) section of trench	Waste similar to spent nuclear fuel	Investigate unique disposals to assess mobility	Yes—Confirm location for Type B probes	Four probes installed—cobalt, cesium, and europium observed, azimuthal survey recommended	4	Run azimuthal survey in Probes T47-IF-1 and T47-IF-2, 7-8 ft; install two more Type A probes using azimuthal data (T47-IF-5 and T47-IF-6).	2	2	—	One lysimeter SE of T47-IF-6 (at bedrock) One lysimeter NW of T47-IF-5 (at bedrock)
1c	Between Pit 15 and Trench 57 – Inventory records indicate fission and activation product disposals.	Fission and activation products	Provide monitoring coverage in the east end of the SDA and compare performance of Type B and conventional lysimeters	No	NA	0	NA	0	3	—	In Well RWMC-2005 (at bedrock) In Well RWMC-2006 (11 ft deep) In Well RWMC-2004 at (16.5 ft deep)
1d	Unrecorded shipment between Pits 1 and 2, and Pit 3.	Radioisotopes	Investigate unrecorded shipment	Yes—Confirm location for Type B probes	Nine probes installed	9	NA	0	—	—	NA
2	West end of Trench 24—Shipment records indicate two 3,000-gal liquid disposals.	Radioisotopes	Assess high-activity liquid waste disposals	Yes—Confirm location for Type B probes	Four probes installed—Probe HAL-2 saturated the gamma tool, high neutron flux observed	4	Run azimuthal survey for low efficiency and shielding to test if actinides are present in high neutron flux	—	2	2	One lysimeter east of HAL2 (21 ft deep) One lysimeter west of HAL2 (21 ft deep) One SMR north of HAL2 (21 ft deep) One SMR south of HAL2 (21 ft deep)
3	Pit 5	Uranium and plutonium	Interrogate several uranium and plutonium disposals in Pit 5	Yes—Confirm location for Type B probes	Eight probes installed—Large quantities of plutonium, americium, neptunium, and uranium confirmed and azimuthal logging recommended	8	Azimuthal survey indicates only one source present east of Probe P5-UEU-4; plan Type B probe cluster with lysimeters	1	4	2	One lysimeter near TW-1 (12 ft deep) One lysimeter near Pit 5-4 at refusal (about 16 ft deep) One lysimeter NE of P5-UEU-4 (14 ft deep) One lysimeter SE of Pit 5-4 (17 ft deep); One soil moisture and resistivity probe west of P5-UEU-4 (sensors at 5 ft and 15 ft deep)
4	Americium/Neptunium Focus Area Depleted Uranium Focus Area	Various	Replace existing, inoperable Type B probes	Yes—Delineate source of moisture at 741-08	Two A probes installed— Azimuthal logging and more Type A probes recommended	2	Azimuthal survey observed source for U-235; two more Type A probes recommended toward plutonium at 741-08	2	10	3	**Am/Np Focus Area (4 lysimeters)—**2 replacement lysimeters: one NW of 741-08-L1 (15.2 ft deep); one south of 741-08-L2 (7.8 ft deep); and 2 new lysimeters: one NE of 741-08 (15 ft deep) one north of 741-08 (11 ft deep) **DU Focus Area (lysimeters and soil moisture and resistivity probes)—**six replacement lysimeters: NW of DU-11 (17 ft deep), NE of DU-11 (11 ft deep), south of DU-14 (13 ft deep), SW of DU-14-A (13 ft deep), north of DU-15 (16 ft deep), south of DU-15 (16 ft deep); three soil moisture and resistivity probes: SW of DU-08-A (sensors at 6.2 ft, 12.3 ft and 18.4 ft deep); west of DU-10-M2 (sensor at 5.8 ft deep); SW of DU-14-A (sensor at 12.3 ft deep)
5	North central part of Pit 6	Plutonium	Investigate RFP shipments with high potential plutonium densities in Pit 6	Yes—Characterize with nuclear logging tools	Three probes installed— Elevated levels of plutonium and americium observed and azimuthal survey recommended.	3	Run azimuthal survey to locate source and plan a Type B cluster	0	2	2	One lysimeter on east side of P6-PU-1 (15 ft deep) One lysimeter 2 ft further east (at refusal) One soil moisture and resistivity probe west of PU-1 (sensors at 5 ft and 15 ft deep)
6	North central part of Pit 10	Plutonium	Investigate RFP shipments with high potential plutonium densities in Pit 10	Yes—Characterize with nuclear logging tools	Three probes installed—No significant detections	3	No source detected	0	0	0	NA
7	Central part of Pit 2	Plutonium	Investigate RFP shipments with high potential plutonium densities in Pit 2. Monitor moisture beneath a geomembrane and at a control location	Yes—Characterize with nuclear logging tools	NA	0	Six probes installed—Significant plutonium and americium observed.	6	4	2	One lysimeter east of P1 (11 ft deep) One lysimeter NE of P1 (15 ft deep) One lysimeter SW of P6 (at refusal) One lysimeter SE of P6 (at refusal) One soil moisture and resistivity probe through geomembrane near Pit 2 One SMR at a control location
Total					0	34		10	36	17	

a. Type A probes are used to obtain nuclear logging data.
b. Type B probes to be installed are an improved version of former Type B probes, and also are known as GEOPs probes.
NRF = Naval Reactor Facility
RFP = Rocky Flats Plant

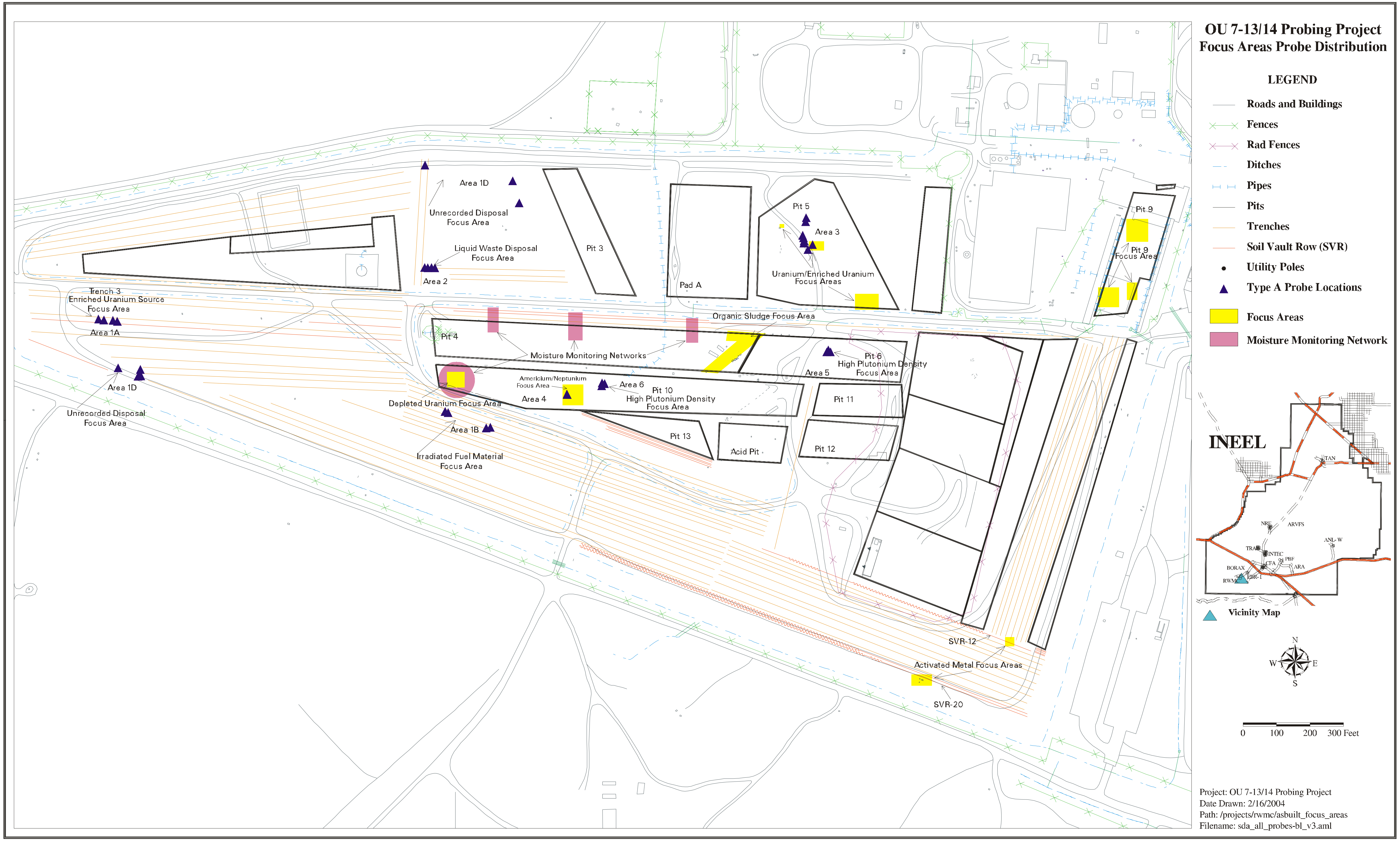

Figure 3-1. Probing locations throughout the Subsurface Disposal Area.

lysimeters and eight soil moisture and resistivity probes were installed in locations where data on contaminant and moisture migration could be gathered (Table 3-6). Seventeen Type B lysimeters and nine soil moisture and resistivity probes also were installed to replace existing, malfunctioning Type B probes.

3.7.3 Additional Probing and Interpretation

Additional probing and interpretation of data from existing Type A and Type B probes will continue to support the OU 7-13/14 RI/FS and decision-making process. Specific tasks include:

- Maintaining the probe database for electronic data (soil moisture and tensiometer data) and populating the database with new data

- Continuing lysimeter, soil moisture probe, and soil vapor probe monitoring

- Preparing an annual probe data summary report that compiles all probe data collected from lysimeters, soil vapor probes, soil moisture probes, and tensiometers.

3.8 Development of the Remedial Investigation/Baseline Risk Assessment

The RI/BRA will be developed in accordance with EPA (EPA 1988) and INEEL guidance (LMITCO 1995a). As discussed in Section 3.1, the ABRA, results from OU 7-08, the tasks described in Sections 3.2 through 3.7, the contents of Appendix A, and the assumptions listed in Table 2-1 provide the basis for the RI/BRA. A summary of the RI/BRA development follows.

For VOCs, new results from work performed by OU 7-08 will be incorporated. Results are expected to be substantially different from those presented in the ABRA, which used scaled IRA estimates. The scaling was based on updated VOC inventory estimates (Miller and Varvel 2001; Varvel 2001). The new VOC modeling will adopt the revised inventories and apply them to a hydrologic model updated to incorporate new data for some key parameters. The model will be calibrated to the extent practicable to VOC concentrations detected in 1996 before operation of the OCVZ vapor vacuum extraction system. The OU 7-08 Project also is producing an estimate of VOCs remaining in the buried waste. This estimate will be used initially to update the RI/BRA nature and extent of VOC contamination. It also will be used in the FS to determine if evaluation of VOC pretreatment is warranted. The updated VOC model being developed by OU 7-08 will be based on the ABRA subsurface transport model, taking advantage of improved model discretization and lithologic representation. The VOC model also will make use of the following new information:

- Updated VOC inventory estimates (Miller and Varvel 2001)
- VOC diffusivity in Series 743 sludge
- Tortuosities of surficial sediments (Varvel and Sondrup 2001)
- Complete operations data for the OU 7-08 vapor vacuum extraction treatment system including VOC mass extracted since operations commenced in 1996 (McMurtrey 2002)
- Measured VOC concentrations in vadose zone vapor and concentrations in groundwater (7 years of data have been collected since the last VOC model calibration)
- VOC vapor concentrations measured beneath the C-D interbed
- Estimates of VOC mass remaining in the source term.

The calibrated VOC model produced by OU 7-08 will be used by OU 7-13/14 to simulate fate and transport of dual-phase C-14. Tritium appears to be a favorable calibration target for vapor-phase modeling. Estimated media concentrations will be used to refine C-14 risk estimates.

Development of the RI/BRA report will comprise compiling, interpreting, and presenting a new version of the ABRA as modified to incorporate elements specified in this *Second Addendum*. DOE will involve personnel from DEQ and EPA throughout the project to ensure success. Routine involvement will include weekly conference calls to keep DEQ and EPA apprised of progress, to discuss issues as they arise and are resolved, and discuss interim results of the various tasks being performed. The RI/BRA report will be provided for DEQ and EPA review as a primary document in accordance with the FFA/CO (DOE-ID 1991) and the project schedule presented in Section 5. Subsequent to resolving and incorporating comments, the RI/BRA will be finalized and placed in the Administrative Record to support remedial decisions for OU 7-13/14.

4. FEASIBILITY STUDY DEVELOPMENT

This section specifies activities to develop the FS. Initial development of the FS is presented in the PERA (Zitnik et al. 2002), which provides development of RAOs, general response actions, technology and process option screening, and assembly of preliminary alternatives. Further development of the FS will focus on (1) reevaluating and revising the assembled alternatives in the PERA considered for detailed analysis, (2) revising the process option evaluation and screening, (3) screening and detailed evaluation of retained alternatives, and (4) developing a balanced comparative analysis (see Section 4.2). Specific tasks to support development of the FS include the following:

- Bench-scale testing, technology evaluations, and safety analyses (Section 4.3)
- Evaluating ARARs (Section 4.4)
- Modeling to assess long-term effectiveness (Section 4.5)
- Developing, testing, and implementing methodology for defining preliminary remediation goals (PRGs) (Section 4.6).

The FS will incorporate information available from the ABRA (Holdren et al. 2002) and the tasks identified in Section 3 of this report to develop the RI/BRA. In particular, waste inventory (Section 3.3) and waste zone mapping updates (Section 3.4), probing and probehole monitoring (Section 3.7), and data from the OU 7-10 Glovebox Excavator Method Project (Section 3.5.5.5) will directly support development of the FS. Additionally, information available within the OU 7-13/14 schedule from non-time-critical removal actions to grout beryllium blocks and retrieve waste from Pit 4, such as the hazard analyses, criticality safety evaluations (CSEs), designs, and operational experience from in situ encapsulation and waste retrieval, processing, and characterization will be incorporated in the FS as appropriate. However, as indicated in Section 2, it is assumed that additional information will not affect preliminary development of RAOs, general response actions, identification of technologies, and assembly of alternatives.

Based on the assumption that source term control will sufficiently reduce risk, the FS is limited to control of the buried waste. Methods to mitigate contaminants that are released into the subsurface in advance of remediation of the source are not evaluated. If source term control alone is subsequently determined inadequate in reducing risk, additional remedial actions will be considered in accordance with the CERCLA process.

4.1 Basis for Development of the Feasibility Study

Remedial technologies and process options that were retained after initial development and screening in the PERA will be explored further during development of the FS. Technologies and options were combined into assembled alternatives to address waste disposal areas within WAG 7 that pose unacceptable cumulative risk. Appendix A lists assumptions and details for development of the FS. The process is summarized below.

4.1.1 Development of Alternatives

Technologies and process options were assembled into preliminary alternatives for remediating the SDA. A range of alternatives was developed to represent distinct, viable approaches to reduce risk to acceptable levels. A No Action alternative also was developed to serve as a baseline against which to compare the range of alternatives.

Preliminary alternatives for remediation were developed in the PERA by evaluating combinations of technologies following the six general steps outlined by the EPA (EPA 1988) as follows:

- Develop remedial action objectives
- Develop general response actions for each medium of interest
- Identify volumes or areas of media to which general response actions might be applied
- Identify and screen the technologies applicable to each general response action
- Identify and evaluate technology process options to select a representative process for each technology type retained for consideration
- Assemble the selected representative technologies into alternatives representing a range of treatment and contaminant combinations.

Five alternatives were developed in the PERA for detailed analysis: No Action; containment; ISG; ISV; and retrieval, treatment, and disposal (RTD). All, except the No Action alternative, are combinations of remedial actions. Assembled alternatives differed primarily in the approach to mitigating risk posed by TRU waste from the Rocky Flats Plant in pits, trenches, and Pad A. These alternatives were evaluated and screened on the basis of implementability, effectiveness, and cost. Alternatives also were evaluated to ensure they will protect human health and the environment relative to potential pathways of exposure. Alternatives were eliminated if they were not protective or feasible to implement. The results of this initial screening are presented in the PERA.

Results of the technology and process option analysis and screening will be revised in the FS to document refined screening that eliminates ISV and other technologies that employ in situ methods to remove or destroy organic contaminants (e.g., ISTD). The alternatives identified for evaluation and screening in the PERA will be reevaluated and modified as described in Sections 4.1.1.1 and 4.1.1.2. The evaluation of implementability, effectiveness, and relative cost for all retained alternatives will be based on results of the safety analysis (Section 4.3.1), bench-scale studies, (Section 4.3.2), additional characterization data, updates to the waste inventory data, data from the OU 7-10 Glovebox Excavator Method, ongoing non-time-critical removal actions, and other available sources. In particular, the FS will incorporate relevant information from other remedial actions on and off the INEEL that share similar characteristics with the SDA.

4.1.2 Remedial Actions Common to All Alternatives

Alternatives developed in the FS will have a number of common remedial actions to address waste-stream-specific issues and achieve RAOs. All the alternatives employ a long-term monitoring program to evaluate the effectiveness of remedial measures. All the alternatives, with the exception of the No Action alternative, also have the following remedial actions in common:

- Site preparation suitable for the remedial action, such as removal of temporary structures
- Pretreatment to mitigate subsidence and provide a stable foundation for a cap

- Continued operation of the OCVZ vapor vacuum extraction system until source term control is achieved and vadose zone RAOs for OU 7-08 are satisfied

- Containment by capping, with the robustness of the cap and the size of the associated restricted access area dependent on the alternative being evaluated

- Long-term operations, maintenance, and monitoring

- Institutional control (release for unrestricted land use is not an expected conclusion from future 5-year reviews).

4.1.3 Development and Screening of Alternatives

Core technologies to address RFP TRU waste and non-TRU low-level waste with mobile mixed fission- and activation- product COCs are central to the development of alternatives. With the common elements described in Section 4.1.2, alternatives to be developed and analyzed in detail in the FS are specified in Appendix A and summarized as follows:

- No Action—The results of the RI/BRA will be used as the basis for the No Action alternative.

- Surface Barrier—Two cap designs will be developed and evaluated: an evapotranspiration (ET) cover and a modified RCRA Type C cover. Two approaches to subsidence—dynamic compaction and grouting—will be evaluated as pretreatment to mitigate subsidence.

  - For the ET barrier alternative, waste on Pad A will be removed and transfered to the LLW pit without treatment or additional engineering of the pit, and an active gas collection layer to enhance the existing vapor-vacuum extraction system will be evaluated. Operation of the existing vapor-vacuum system will continue until OU 7-08 remediation goals are achieved.

  - For the modified RCRA Type C barrier alternative, Pad A waste will be left in place and incorporated into the barrier design. No gas collection layer will be included in the modified RCRA Type C barrier; instead, shallow extraction wells will be constructed and operated concurrently with the existing vapor-vacuum system until OU 7-08 remediation goals are achieved.

- In situ grouting (ISG)—The ISG alternative represents grouting waste in place to immobilize contaminants. Waste on Pad A will be removed, grouted ex situ, and placed in a pit at the SDA. An ET cover that includes an active gas collection layer will be installed over treated areas and extended to cover the remainder of the SDA. Operation of the existing vapor-vacuum system will continue until OU 7-08 remediation goals are achieved.

- Partial RTD—For the partial RTD alternative, four acres of RFP TRU waste will be identified as an example, removed, segregated, treated as necessary, and disposed of using the Accelerated Retrieval Project approach. The TRU waste will be shipped to the Waste Isolation Pilot Plant (WIPP) and the remaining waste will be left in the pits. Pad A waste will be removed and segregated; the TRU waste fraction will be shipped to WIPP, and the remaining waste will be transferred to the INEEL CERCLA Disposal Facility (ICDF) for treatment and disposal. An ET cover will be installed over excavated areas and the remainder of the SDA. The existing vapor-vacuum system will be operated until OU 7-08 remediation goals are achieved.

- Full RTD—The full RTD alternative evaluates excavation, sorting, treatment, and disposal of all waste from the SDA. Retrieved and treated materials would be dispersed to appropriate engineered facilities on or off the INEEL in accordance with various waste acceptance criteria. Candidate facilities off the INEEL include WIPP, the Nevada Test Site, and Envirocare. Candidate facilities at the INEEL are the ICDF and the Central Facilities Area Landfill. The RFP TRU and alpha-contaminated waste would be retrieved first (approximately 17 acres), followed next by the contact-handled and remote-handled waste in pits, trenches, and soil vaults (approximately 12 acres), and lastly the LLW in Pits 17-20 (approximately 6 acres). The Accelerated Retrieval Project approach will be used as the basis for estimating cost for RTD of all waste forms, though it will be aknowledged in the FS that this basis is not completely representative and may underestimate cost. An ET barrier will be installed over the SDA and the existing vapor-vacuum system will be operated until OU 7-08 remediation goals are achieved. As a basis for cost estimates, it is assumed that up to 1 acre of waste will be excavated with no more than two, 1/2-acre concurrent retrievals from 2005 through 2035, minus time needed to install the final ET barrier and complete remediation of OU 7-13/14 by 2035.

4.1.4 Evaluation Based on CERCLA Criteria

Remedial technologies and process options identified for OU 7-13/14 will be evaluated individually and comparatively against the threshold, balancing, and modifying criteria defined by the EPA (EPA 1988) in accordance with the National Contingency Plan (40 CFR 300). Threshold and balancing criteria will be assessed in detail for all assembled alternatives in the FS. Modifying criteria will be evaluated in the proposed plan and ROD. The nine CERCLA criteria are:

- Threshold criteria:
  - Overall protection of human health and the environment
  - Compliance with ARARs
- Balancing criteria:
  - Long-term effectiveness and permanence
  - Reduction in toxicity, mobility, and volume of contaminants through treatment
  - Short-term effectiveness
  - Implementability
  - Cost
- Modifying criteria:
  - State acceptance
  - Community acceptance.

Additional characterization data, waste inventory updates, FS studies and assessments, and information from non-time-critical removal actions will be incorporated into the FS. Results from preliminary documented safety analyses (PDSAs) and CSEs will be used to evaluate implementability.

Long-term effectiveness evaluations incorporate results from bench-scale studies and FS residual risk assessments. Results of bench-scale studies also will be used to augment technology performance evaluations relative to reduction of toxicity, mobility, and volume of COCs. Upgrades to the buried waste information will generate refinements to estimated volumes and areas for remediation, which will affect cost estimates for the various assembled alternatives.

4.2 Detailed and Comparative Analysis of Alternatives

Objective evaluation of the benefits, deficiencies, and costs of the remedial alternatives will be performed to address core technologies and common elements. Specific tasks include the following:

- Define waste areas and volumes that require remediation with more precision using data from probing and probehole monitoring, waste inventory updates, and other buried waste information
- Identify and quantify waste streams that could impede remediation and determine locations of the waste based on shipping records
- Evaluate long-term effectiveness, permanence, and reduction of mobility, toxicity, and volume through treatment using results from bench-scale tests
- Refine waste form parameters for the FS risk assessment modeling using results from bench-scale tests and updated information from scientific literature
- Examine in depth technical and administrative issues associated with implementing alternatives using results of safety and hazard assessments; evaluate short-term effectiveness and implementability accordingly
- Review ARARs and describe how alternatives would comply with potential ARARs
- Define WIPP waste acceptance criteria and process as they would apply to the partial and full RTD alternatives; coordinate with WIPP personnel to ensure that procedures are consistent with WIPP requirements and that assumptions used in the FS are realistic
- Review assumptions that support cost estimates; revise as required to reflect realistic requirements to implement the alternatives, and refine cost estimates accordingly
- Compare and contrast alternatives relative to CERCLA criteria after the individual analyses are complete.

4.3 Preremedial Design Investigations

Administrative implementability is an uncertainty associated with candidate technologies for remediating the SDA. Safety issues and concerns to implement the respective alternatives were evaluated to develop assurance that the technologies are feasible for use at the SDA. A PDSA and CSE were developed for ISG, ISTD, and ISV in anticipation that all these technologies would be evaluated in the FS. However, available information indicates that ISTD and ISV should be screened out as viable technology and process options for the SDA. A hazard analysis, CSE, and fire hazard analysis also are being performed as part of the Accelerated Retrieval Project to remove waste from the SDA.

In addition to surrogate waste, several types of actual waste are available for bench-scale tests. Candidate waste includes waste retrieved from Pad A in 1988 and waste and soil removed from Pit 9 by OU 7-10. Waste and soil retrieved from Pit 9 were used for laboratory analysis and bench-scale testing. Test objectives focused on ISTD safety and effectiveness, ISG effectiveness, and ISG-ISTD interactions and their effectiveness on actual waste. Field-scale tests to support SDA remediation will be performed post-ROD if required during remedial design.

4.3.1 Administrative Implementability—Safety Analysis

The PDSA (Santee 2003) and CSE (Sentieri 2003a) for ISV identified safety class or safety-significant features required for its use in the SDA. Understanding the safety implications of implementing ISG technologies in the SDA is required to adequately assess overall feasibility. Sufficient experience-based knowledge for containment is available, thus precluding the need for a PDSA to support FS evaluation. For partial and full RTD, OU 7-13/14 will rely on information provided from the Accelerated Retrieval Project to evaluate the implementability of retrieval, ex situ treatment, and disposal of SDA waste.

The ISG PDSA (Abbott and Santee 2003) addressed ISG as a core technology for RFP TRU waste and as a common element in all assembled alternatives for non-RFP waste to immobilize non-TRU COCs and to control subsidence. To maximize effectiveness and reduce worker risk, an innovative XY plotter mechanism over thrust block methodology was assumed for the analysis. Preconceptual designs were developed to support large-area application of ISG to the SDA. Tasks included development of preliminary technical and functional requirements, process and operational descriptions, and preconceptual designs. The preconceptual design ensures the PDSA for ISG is comprehensive for the entire SDA. In parallel with development of the PDSA, a CSE for ISG examined application of ISG to the entire SDA (Sentieri 2003b). The PDSA and CSE showed ISG can be conducted safely and would not pose a criticality hazard.

Retrieval of waste from Pit 4 at the SDA is being performed as a non-time-critical removal action. To identify and assess requirements for waste retrieval, a PDSA, CSE, and fire hazard analysis are being performed and a retrieval design was developed. Any information from this effort made available during development of the FS will be incorporated as permitted by the schedule constraints.

4.3.2 Technology Effectiveness—Bench-Scale Tests and Technology Evaluation

Bench-scale studies are being performed to evaluate effectiveness of ISG and ISTD under conditions and scenarios unique to the SDA. These studies are designed such that interactions between the two technologies can also be evaluated.

The test plan for the bench-scale studies was developed so that the results of the tests will be available for incorporation in the FS (Yancey et al. 2003). A series of bench-scale tests using surrogate waste is being performed initially to validate test approaches and confirm procedures. Further bench tests are being conducted on surrogate waste. Planned radiological bench tests will use material with low specific activity. Such materials may be spiked surrogates, waste retrieved from Pad A in 1988, and waste and soil removed from Pit 9 by the OU 7-10 Glovebox Excavator Method Project. All preparations for hot testing will be performed before accepting material from Pit 9.

Bench-scale studies for ISG have been conducted to evaluate performance of various grouts to waste in the TRU pits and trenches (Loomis et al. 2002). However, grouts have not yet been identified for application in soil vaults, non-RFP waste trenches, or nitrate salts. In addition, all work to date on grouts applicable to TRU pits and trenches was performed with nonradioactive tracer materials in surrogate waste; studies using radionuclides of concern and actual waste material retrieved from the SDA will substantially reduce uncertainty. The main goal for ISG and ex situ grouting is to reduce risk to human health and the environment by physically stabilizing the waste and immobilizing COCs. To establish the suitability of ISG and ex situ grouting options as waste treatments applicable to the SDA, the grouting process and the grout and waste matrix must exhibit the following attributes:

- Long-term durability—The life expectancy of the in situ grouted matrix to provide protection to human health and the environment will be determined through testing and empirical derivations.

- Decreased hydraulic conductivity—Hydraulic conductivity of various waste and grout mixtures will be determined. Results will be used in the FS risk modeling effort and for assessment of long-term effectiveness.

- Low set temperature—Grouts will be tested to determine set temperatures. Grout must have a set temperature less than 100°C. Grouts that produce temperatures higher than the boiling point of water could produce steam, which could lead to expulsion during the curing process.

- Chemical buffering—Some grout materials were selected for testing because they may affect the groundwater chemistry and waste component solubility by chemical buffering. Oxidation-reduction potential (Eh) and the acid-base character (pH) of groundwater within the grouted matrix are buffered by the grout and reduce waste component solubility, and therefore reduce mobility of some waste components. Chemical buffering by the grout is expected to last 1,000–10,000 years or more (Alcorn, Coons, and Gardner 1990).

- Physical stability—The injected grout mixture will stabilize the buried waste by filling voids in the waste and associated soils, preventing site subsidence and accumulation of surface water.

- Administrative feasibility—Associated administrative requirements to be addressed before, during, and after the grouting process will be identified and evaluated as part of the technology assessment.

- Minimum contaminant release during in situ grouting—All aspects of the grout emplacement process will be examined to evaluate the potential for contaminant release to the environment from the operation. The performance of designed safety systems will be evaluated against safety and as-low-as-reasonably-achievable goals established for the project.

- Minimum grout interference and maximum compatibility—Soil, nitrate salts, and organic sludge in the waste can interfere with grout effectiveness by degrading properties of the grouted matrix. Tests will be conducted to identify grouts that allow good treated waste formation with high interference loadings.

- Encapsulating or immobilizing contaminants—The grout material will be tested to evaluate effectiveness for encapsulating waste components and immobilizing COCs.

- Minimal secondary waste—Grout operations and product and hardware designs will be developed to minimize the generation of secondary waste. Process designs minimize hardware exposure to potentially contaminated subsurface materials to prevent cross contamination and subsequent waste generation.

Test objectives for ISG and ex situ grouting bench-scale studies were developed based on an evaluation of data gaps identified in Section 2. Test objectives were established to collect data sufficient to satisfy existing data gaps and to enhance information regarding the effectiveness and implementability of ISG and ex situ grouting as applied to waste at the SDA. Bench-scale studies for ISG and ex situ grouting will address the following goals:

- Develop data to support contaminant transport modeling for treated waste forms
- Evaluate the physical stability and durability of grouted waste forms
- Determine implementability and effectiveness of a paraffin-based grout formulation
- Investigate grouting material and waste pretreated by an ISTD process.

The ISTD testing was designed to obtain data to determine if thermal desorption will be a viable and effective treatment for the RFP organic sludge buried at the SDA. Bench-scale tests are being conducted to determine VOC and salt destruction and removal efficiencies. The general approach is to heat soil and waste samples; allow to cool; characterize for physical properties, gross chemical composition, actinide composition, and crystalline structures; and test for durability and leaching potential. Several ISTD operating temperatures are being evaluated. Significant quantities of volatile and semivolatile organics can be removed at low temperatures (~100^{o}C). At higher temperatures (450^{o}C), nitrate salts also will be degraded. Aspects being evaluated during ISTD bench-scale tests include:

- Heated waste interactions—Potential reactive interactions between combustible debris organic sludge and nitrate salts will be investigated. An important safety factor for ISTD is heating waste materials—such as nitrate salts commingled with organic material (e.g., paper and machine-cutting oils)—without causing uncontrolled reactions in the RFP TRU pits and trenches. Reactivity of nitrates and organic material will be determined in specialized bench tests.
- Gas evolution—Gases generated during heating will be monitored.
- Physical stability—Soil and waste mixtures will be tested after heating to evaluate physical stability.
- Contaminant release and secondary waste generation—The ISTD process will be examined to evaluate the potential for contaminant release to the environment from the well emplacement operation and during treatment.

Test objectives for ISTD bench-scale studies were developed based on an evaluation of data gaps identified in Section 2. Test objectives were established to collect data sufficient to satisfy existing data gaps and to enhance information regarding the effectiveness and implementability of ISTD as applied to waste at the SDA. Bench-scale studies for ISTD address the following goals:

- Determine the degree of organic and salt destruction at various temperature ranges
- Test bounding nitrate-organic mixtures for reactivity at various ISTD operating temperatures
- Determine the off-gas components as waste and soil mixtures are heated
- Estimate the potential for release of COCs after treatment
- Perform ISTD testing using radiological material retrieved from Pit 9, Pad A, or spiked surrogate waste
- Investigate ISTD as a pretreatment for capping, ISV, ISG, and RTD.

4.4 Evaluation of Applicable or Relevant and Appropriate Requirements

The PERA identifies preliminary ARARs for all evaluated remedial alternatives. However, identification of ARARs will continue through a phased analysis during development of the FS. The ARARs evaluation will be coordinated with DEQ and EPA personnel to achieve consensus on the regulatory strategy, and the results will be incorporated in the FS. Evaluation of the ARARs includes:

- Assessing the relevant substantive requirements of subject regulations and DOE Order 435.1 (2001)
- Identifying interrelationships among the regulatory requirements
- Evaluating implementation issues (e.g., technical and regulatory).

Major ARARs associated with alternatives undergoing detailed analysis will be integrated into the description of the respective alternatives. For the Full RTD alternative, strategies will not be developed for ARAR-compliant treating, storing, and disposing of waste with no current path to disposal (e.g., beryllium blocks and other very high-activity waste), but will be qualitatively evaluated. In addition, the FS will include an appendix that summarizes candidate federal and state ARARs in a table format. The table will include the regulatory citation (ARAR), justification of the ARARs, an indication of which ARARs apply to the various alternatives, and a summary of how the alternatives will satisfy the ARARs. The specific requirement will be stated in addition to the appropriate regulatory reference.

4.5 Feasibility Study Risk Assessments

The FS risk assessment will be used in developing a comparative analysis of the benefits and deficiencies in the remedial alternatives. The fate and transport model used in the PERA was developed for the ABRA, which forms the basis for the BRA. However, to assess long-term effectiveness adequately, some of the limitations of the ABRA risk assessment will be addressed. These limitations primarily consist of inadequate calibration of the ABRA source release and fate and transport models, which result in inconsistencies between trends in current observed monitoring results and simulation results. As explained further in the following paragraphs, this limitation makes evaluating risks of treated contaminants within the surficial sediments problematic because significant quantities of contaminants are simulated to have already migrated beneath the waste zone into the underlying soil and rock. The released contaminants could constitute sources in the vadose zone and aquifer that also must be evaluated for impact on total risk.

The following sections (1) discuss the models used to perform the fate and transport simulations for the risk assessment, and (2) describe the proposed improvements for the FS simulations to support evaluation of long-term effectiveness. Additional details for exposure scenarios, model parameters, and model runs are provided in Appendix A.

An approach to evaluating plutonium transport evaluations was developed, as described in Table 2-4 and Appendix A.

4.5.1 Source Release Modeling

A key factor affecting residual risk is contaminant release before and after remediation. To estimate residual risk for comparison of remedial alternatives, the base-case simulations (i.e., No Action alternative) should mimic general trends in monitoring data. Contaminants released into the subsurface before remediation could create an additional source that may impact the aquifer. Since scope for OU 7-13/14 limits remedial actions for the SDA to source term treatment, the potential impact of this additional source, along with inventory remaining in the SDA, will be assessed. Contaminants released into the subsurface after remediation determine the long-term effectiveness of remedial alternatives and must be assessed in the remedy selection process.

As a basis for estimating source releases, soil-to-water partition coefficients (see Appendix A) are used. Because waste zone data are presently limited, the decision to use soil-to-water partition coefficients is based on the assumptions that the waste and soil are mixed and that contaminants partition with soil. This assumption may be revised as site-specific information about contaminant release rates is determined from analysis of probe data.

Source release model calibration will be limited. Because Type B probes have not produced sufficient sample volume to support source release model calibration, key inputs for the source release model will come from a variety of sources available within FY 2004 and 2005. Sources include bench-scale tests, current scientific literature for the various remedial alternatives, and available site-specific information. Technology- and contaminant-specific release rates were developed for long-term effectiveness modeling (see Appendix A). As for the IRA and ABRA models, indirect source release model calibration will be attempted through fate and transport model calibration exercises. Source release information developed in the future, such as additional Type B probe monitoring data and results from analysis of material retrieved from Pit 9 by OU 7-10, can be evaluated against model results to qualitatively assess uncertainty.

For the ABRA source term model, the SDA was divided into source areas based on waste type and physical disposal areas. Emphasis was on RFP waste; therefore, the pits were each assigned to a source area. In general, this representation provided adequate detail for actinide waste streams, but not for fission product and activation product waste streams. For the FS, further refinement is planned. Instead of 13 discrete sources areas, 18 will be discretized as described in Appendix A.

4.5.2 Subsurface Modeling

Predictions of future concentrations in the aquifer derived from releases from contaminants remaining in the SDA after remediation and from contaminants released to the vadose zone before remediation are necessary to evaluate and choose between remedial alternatives being considered for the buried waste in the SDA. Numerical simulation is the tool for predicting these future concentrations. Numerical simulations are simplified representations of physical and chemical processes that affect the movement of contaminants in the subsurface. The reliability of the predictions depends on the degree of success in demonstrating either that (1) the simulations adequately represent observed key subsurface transport features or (2) the simulations are conservative and predict a faster transport than is observed. These key transport features are considered calibration targets that consist of monitored concentrations derived as a function of time at various depths. However, as was seen in Olson et al. (2003), obvious transport calibration targets are not yet in either the vadose zone or the aquifer for dissolved-phase transport. Although some calibration targets are suggested, there is sufficient uncertainty over the representativeness of the data and whether trends are actually evident to preclude definitive statements as to which calibration targets the flow and transport simulations should match.

Because there are no calibration targets for modeling transport beneath the SDA, simply using conservative representations is not advised. Overconservatism can lead to unnecessary remedial actions. This emphasizes the importance of making simulations as representative as practicable. Accounting for the limitations of target calibrations, the steps outlined in this section define a program to refine the

ABRA subsurface flow and transport model such that it more accurately represents subsurface contaminant movement at the SDA; hence, results can be used to reliably assess long-term effectiveness of remedial alternatives.

In the remainder of this section, assumptions that will be used in the simulations are presented to explain the basis for either representativeness or conservatism. These assumptions are followed by the steps through which the modeling will be completed.

4.5.2.1 Assumptions. This section lists all assumptions that resulted from the conceptual model implemented in the ABRA and additional assumptions that will be necessary for the FS subsurface modeling. Assumptions are divided into flow and transport categories. Most of these assumptions are the same as those used in developing the ABRA model. Italicized portions indicate what is or may be different from the ABRA. These assumptions are applied only to dissolved-phase subsurface flow and transport modeling.

4.5.2.1.1 Flow Modeling Assumptions—Flow modeling assumptions include:

- Infiltration is spatially variable inside the SDA and is greater than the infiltration that occurs outside the SDA because of disturbed soil profiles with reduced vegetation.

- The infiltration description of Martian (1995) adapted for the ABRA model may be adequate for the FS No Action modeling, subject to confirmation through ongoing efforts to quantify infiltration through the waste by way of the Type B probe monitoring.

- The higher infiltration rate, beginning in 1952, is implemented as though it were effective across the SDA.

- The background infiltration rate outside the SDA through undisturbed vegetated sediments is 1 cm/year (0.4 in./year).

- Initial conditions obtained from simulating a background infiltration rate of 1 cm/year (0.4 in./year) for 100,000 days (approximately 274 years) are adequate for representing the vadose zone beneath the SDA.

- The amount of water entering the SDA from the three historical floods is adequately estimated by Vigil (1988).

- Duration of infiltration from each of the historical flooding events is 10 days.

- Infiltration patterns at the SDA will remain the same indefinitely into the future for the FS No Action simulations and will be revised for the treatment cases to reflect the impact of an infiltration-reducing cover.

- The high infiltration rate assigned over parts of the SDA by Martian (1995) is sufficient to account for occasional flooding of the SDA that may occur in the future for the FS No Action simulations.

- The surficial sediments and sedimentary interbeds have spatially variable lithologic surfaces and thicknesses that influence water and contaminant movement.

- Interbeds below the C-D interbed are thin and discontinuous and do not significantly affect flow and transport near the SDA.

- Hydrologic properties in the surficial sediments and A-B interbed are homogeneous. Hydrologic properties in the B-C and C-D interbeds are heterogeneous and varied spatially.

- The B-C and C-D interbeds have a low-porosity, low-permeability feature at their upper surface, which indicates either sediment within the interbed or the effect of fracture infilling by fine-grained sediments in the low-permeability basalts immediately above the interbed. (Though this feature was included in the subsurface model and discussed in detail in IRA and ABRA modeling text, it was not specifically identified as an assumption.)

- Waste has the same hydrologic properties as the surficial sediments.

- Flow in the fractured porous basalts is controlled by the fracture network and is adequately represented as a high-permeability, low-porosity, equivalent-porous continuum using a Darcian description.

- The field-scale hydraulic properties for fractured basalts were previously described by the inverse modeling performed by Magnuson (1995) for the large-scale infiltration test. This description may be revised as part of the calibration of the dissolved-phase transport model.

- The ABRA model includes a steady-state influence in the vadose zone from Big Lost River water discharges to the spreading areas. This influence is represented as additional water entering the simulation domain just above the C-D interbed and includes enough water to affect the western portion of the C-D interbed beneath the SDA. Since the effect of this influence primarily serves to dilute contaminant concentrations in the vadose zone and the aquifer, the spreading area influence will not be simulated to be conservative.

- Any spreading area influence on the vadose zone began in 1965, as that was the year when the first significant flows in the Big Lost River occurred after the diversion dam was constructed in 1958 (Wood 1989).

- Water movement in the aquifer is treated as steady state. Possible influences of discharges from the Big Lost River to the spreading areas do not influence flow in the aquifer in the immediate vicinity of the SDA.

- Water levels corrected for borehole deviations from FY 2001 are adequate for calibrating the Snake River Plain Aquifer model and are representative of long-term, steady-state conditions.

- A region of low permeability exists in the aquifer southwest of the SDA.

- The effective depth of the Snake River Plain Aquifer is 76 m (250 ft) (Robertson, Schoen, and Barraclough 1974).

4.5.2.1.2 Transport Modeling Assumptions—Transport modeling assumptions include:

- FS remedial actions will treat (1) all estimated contamination that is retained in the waste at the time of treatment and (2) all contamination that has been released that is still within the surficial sediment portion of the vadose zone model. (This is consistent with the approach used in the PERA.)

- Field-measured concentrations of contaminants are generally representative and valid based on data quality requirements associated with sampling activities. Single isolated detections of contaminants are anomalous and not representative because they are not consistently present.

- Advection, dispersion, diffusion, sorption, and radioactive decay are the only processes that influence dissolved-phase contaminant movement in the subsurface beneath the SDA.

- A linear equilibrium reversible partition coefficient is representative of all geochemical processes that occur between contaminants dissolved in water and sediments. All available site-specific information will be used to determine appropriate contaminant partitioning coefficients. Radioactive decay also will be accounted for in the simulations.

- Partition coefficients are homogeneous in the interbeds. Uranium and neptunium may be treated as spatially variable if information becomes available to justify this.

- Sorption does not occur in fractured basalt portions of the vadose zone and aquifer.

- There are no upgradient influences from other INEEL facilities on aquifer contaminant concentrations near the SDA, with the exception of nitrate, which has an estimated local background concentration of 0.7 mg/L.

4.5.2.2 Subsurface Modeling Steps. Six steps are defined for subsurface fate and transport modeling to assess long-term effectiveness: (1) model selection, (2) infiltration modeling, (3) dissolved-phase transport modeling, (4) combined dissolved-phase and vapor-phase transport modeling for VOCs, (5) combined dissolved-phase and vapor-phase transport modeling for radionuclides that partition into the vapor phase, and (6) FS treatment modeling. These steps are outlined briefly as follows with detailed explanations afterwards:

- Model selection—This task involves reviewing and selecting source release and subsurface modeling codes that could be used for the OU 7-13/14 FS. The selected codes could replace the DUST-MS and TETRAD codes that have been used to develop previous SDA risk assessments in the IRA (Becker et al. 1998) and the ABRA (Holdren et al. 2002). DUST-MS and TETRAD are not widely used in the DOE complex. TETRAD requires substantial computing resources and long simulation times.

- Infiltration modeling—This task involves evaluating the spatial variability of infiltration rates into and through waste at the SDA. These infiltration rates are one of the key parameters controlling subsequent movement of transport in the subsurface. The results of this evaluation will be used to support the FS No Action subsurface modeling. This modeling assumes there will be some consolidated and analyzed transient data developed by the SDA probing project against which to develop calibrated infiltration models.

- Dissolved-phase modeling—This task involves evaluating the use of mobile contaminants that only exist in the dissolved phase for calibrating the base-case model. The ABRA model would be updated and then used to establish an FS No Action model and to evaluate FS remedial alternatives for those COCs that were simulated to have migrated deeper than the surficial sediments. For purposes of calibration, the updated model will be run uncalibrated from a transport perspective and compared to specific trends in contaminant monitoring, such as uranium in the west end of the SDA and around Pad A. This approach will be used since monitoring results to date have not been useful in identifying appropriate dissolved-phase calibration targets that are representative of general contaminant behavior. All relevant data available within the OU 7-13/14 FS production schedule, such as perched water analysis, will be incorporated into the modeling.

- Volatile organic compound vapor-phase model development—This is an OU 7-08 task and involves updating the OCVZ combined dissolved- and vapor-phase model to account for recent monitoring and organic mass estimation results. The updated vapor-phase model will be used to support development of the OU 7-13/14 FS.

- Radionuclide vapor-phase transport analysis—This task involves evaluating the potential for vapor-phase transport of radionuclide COCs in the subsurface beneath the SDA. Vapor-phase transport of radionuclides is a potentially important transport mechanism because it could cause relatively rapid movement of some of the highest risk COCs buried in the SDA (e.g., C-14 and potentially Tc-99). Vapor-phase transport also allows contaminant mass to realistically leave the simulation domain through the land surface by way of diffusion. The results of the vapor-phase transport analysis will be used to support the OU 7-13/14 FS subsurface modeling effort. All relevant radionuclide vapor-phase data available within the OU 7-13/14 FS production schedule will be applied in the modeling effort.

- FS treatment modeling—Some evaluations of FS alternatives will be accomplished by comparing cumulative residual contaminant release from just the source term model from treated waste as a function of time (see Appendix A). This approach allows direct comparison between treatment methods. It is anticipated that the more likely treatment candidates determined in this manner will be further evaluated for the entire groundwater pathway risk using the model developed in the previous steps. This task involves simulating flow and transport through the vadose zone and the aquifer using source releases reduced by remedial action. Results of the BRA base case simulations up to the time of implementing an alternative will serve as the initial conditions for the treatment simulations. The contaminant mass remaining within the source zone in the vadose zone model at the time of implementing treatment and the contaminant mass that has not yet been released from the source model provide total contaminant inventory that is treated. Using simulated conditions and contaminant concentrations for the rest of the vadose zone model as initial conditions for the treatment simulation adds the impact of residual contaminants migrating from the treated waste to those contaminants that migrated before treatment to ensure environmental protection. The migration of contaminants from the treated waste also will be simulated in the absence of the previously released contaminants to distinguish between the proposed treatment alternatives.

For the ABRA, the DUST-MS and TETRAD simulators were used for the source release modeling and for flow and transport modeling, respectively. These two simulators were used exclusively since 1996 for simulating the release and movement of contaminants at the SDA. A considerable investment was made to discretize and parameterize this model and develop pre- and post-processors. Nevertheless, advances in numerical simulation were made during the last decade, and it is to the benefit of the OU 7-13/14 Project to ensure that the most appropriate simulation code is being used. To this end, a model selection exercise was conducted. This exercise applied the findings of a similar code evaluation effort conducted for WAG 3 that was terminated before completion. The WAG 3 effort was leaning strongly toward selecting the STOMP simulator (White and Oostrom 1996) as a potential replacement for TETRAD. Therefore, the model evaluation effort for WAG 7 focused on STOMP and two other proprietary codes, MODFLOW-SURFACT and FEFLOW, in addition to TETRAD. The evaluations for the flow and transport model and for the source release model are presented in Appendixes C and D, respectively. The evaluations resulted in the retention of TETRAD and DUST-MS for use by OU 7-13/14.

The infiltration-modeling task applies Type B probe data to estimate the amount of water that passes through the waste zones. This amount of water, along with the mechanism of release from the buried waste, is the key parameter controlling transport down to the underlying aquifer. Vertical infiltration and horizontal movement within the waste zone, attributed to increased infiltration in low-lying areas such as ditches, may serve to focus and increase infiltration near emplaced waste. Matric potential and soil moisture data will be applied in one- and two-dimensional inverse modeling to estimate the amount of water that infiltrates through the waste. This modeling exercise also will serve to select where replacement instruments are most necessary for those instrumented probes that are not functioning.

The ABRA model predicted that enough uranium mass has already migrated into the underlying vadose zone to pose a potential future health risk through the groundwater pathway. Though modeling results are not corroborated by monitoring data, some trends in the monitoring data appear in agreement with modeling results. Figure 4-1 shows a comparison of the simulated and measured concentrations of U-238 at the W23 location in the western end of the SDA. Lysimeters L09, L08, and L07 are at depths of 18.8, 11.8, and 7.7 ft, respectively. Anthropogenic uranium concentrations might be increasing at this location. (Trends are tentatively interpreted from monitoring data, and an increasing trend appears to be developing.) As shown in the figure, the simulation results overpredict measured concentrations, indicating that the ABRA model results are conservative from the perspective of maximizing transport down to the aquifer, at least at this location.

The FS simulations will primarily address that portion of the mass simulated to remain in the source zone where it can be treated. Because so much mass is simulated in the ABRA model to have migrated out of the source zone, FS simulations strictly using the ABRA simulation results would not necessarily be conservative. If the mass present in the waste zone were underpredicted, the FS simulations would underpredict future concentrations. To preclude this possibility, the ABRA model will be refined to improve its representativeness when compared to field-monitoring data. This requires that the model accurately simulate water behavior as observed from (1) the advanced tensiometer-monitoring network, (2) the measured distribution of perched water, and (3) the measured contaminant concentrations in the Type B and vadose zone monitoring networks. Appropriate comparison targets will be selected for water behavior from McElroy and Hubbell (2002) and likely contaminants for calibration (Olson et al. 2003), and the necessary model parameters will be adjusted. In addition to COCs, chromium will be considered for use as a comparison target although it is not necessarily ideal because of its complicated multivalence state chemistry. This dissolved-phase model comparison will include possible revisions to the source release model.

The revised model, with its greater representation of actual conditions in the SDA and in the vadose zone, will provide an improved basis for assessing long-term effectiveness.

As part of the dissolved-phase modeling, updated partition coefficients for neptunium and uranium may be implemented, depending on the final results from the partition coefficient analysis that is being completed for the OU 7-13/14 Project at Clemson University. This will probably include spatially variable partition coefficients for neptunium and uranium in the B-C and C-D interbeds.

In the ABRA, C-14 is predicted to pose unacceptable risk for the groundwater pathway. However, the model used for the ABRA did not consider vapor-phase transport of C-14. The OU 7-08 Project is developing an improved VOC model based on the ABRA model that considers both dissolved- and vapor-phase transport of volatile organics (see Section 3.2.5.1). This improved dual-phase model will be used to reevaluate groundwater pathway risks for C-14 to account for vapor-phase characteristics. Thus, appropriate remedial actions can be defined to treat waste streams containing C-14 effectively.

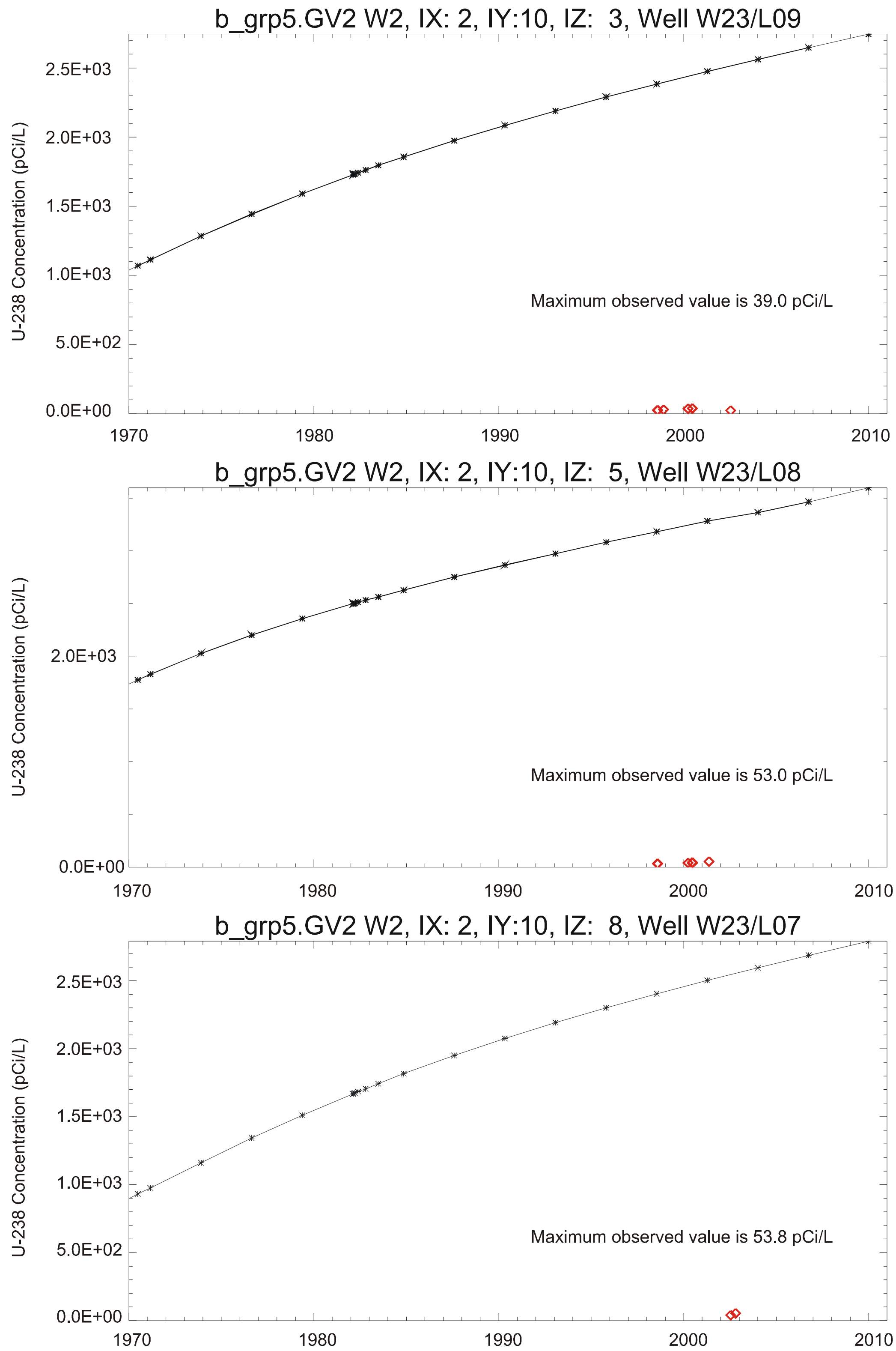

Figure 4-1. Simulated and measured concentrations of U-238 in surficial sediment lysimeters W23/L09, W23/L08, and W23/L07 at depths of 7.7, 11.8, and 18.8 ft below land surface. (Simulated values are shown as asterisks and observed values as red diamonds.)

Partitioning parameters for C-14 were developed in column studies (Plummer, Hull, and Fox 2004) and will be incorporated in the FS modeling. Tritium, though not a COC, may be a good FS model calibration target for vapor-phase transport. Tritium monitoring data are relatively abundant and useful for comparison purposes for the dual-phase model.

Assessment of the validity of the FS modeling is likely to continue beyond development of the FS. Probable activities include comparing infiltration rates assigned in the FS base-case model to those observed from the Type B instrumented probes installed in waste at the SDA. Additional observations of water behavior from perched water wells and from the advanced tensiometer network in the B-C and C-D interbeds also could demonstrate whether the BRA base case, which is synonymous with the FS No Action alternative model, is conservative. Type B probes and the advanced tensiometer network also would support comparisons of actual-to-predicted cap performance. Multiyear baseline moisture conditions in the vadose zone will be established through continued monitoring and used to judge the effectiveness of the final remedy. As indicated in Section 3, monitoring will continue until 1 year after the ROD is finalized in accordance with this *Second Addendum*. Additional monitoring requirements will be identified in the ROD.

4.5.3 Risk Estimates

Media concentrations developed through modeling will be applied to estimate residual risks for each alternative. The FS model will be used to assess residual risk when alternatives are implemented. Media concentrations based on treatment technology performance will be estimated. The BRA base case will serve as starting conditions for the alternative simulations. This starting point then includes contaminants in the vadose zone deeper than the surficial sediments and adds the effect of releases of contaminants from the treated waste. A related simulation also will be performed for each treatment that will consider only the effect of the releases from the treated waste in the absence of contaminants that may already have migrated deeper than the surficial sediments. These combined simulation results will be used for detailed and comparative analysis of remedial alternatives. These results also will be used to evaluate the assumption that treatment of the source term will be sufficient to mitigate risk.

The FS risk estimates will address BRA exposure scenarios with cumulative risk in excess of remedial action objectives. The estimates will be based on the same exposure parameters (e.g., duration, frequency, and mass) as used for the BRA (see Section 3.8). Except for the acute well-drilling scenario, these parameters are thoroughly described in the ABRA and are not repeated here (see Section 6 of Holdren et al. 2002). An acute well-drilling scenario for an agricultural irrigation well will be evaluated as specified in Appendix A using the parameters specified in Table 4-1.

Table 4-1. Acute well-drilling scenario parameters for an agricultural irrigation well.

Parameter	Value	Comment
Area well cuttings are spread over	2,200 m^2	1/2-acre lot
Exposure time	160 hours	—
Well diameter	55 cm	Irrigation well, not residential well
Dust loading	1 mg/m^3	—

4.6 Development of Preliminary Remediation Goals

Preliminary remediation goals (PRGs) for human health will be developed using a combination of GWSCREEN runs and risk estimates produced by scaling (i.e., multiplying the BRA risk estimate times technology flux divided by BRA flux). Human health PRGs will be calculated for the hypothetical future residential scenario only. For carbon tetrachloride, methylene chloride, and tetrachloroethylene, OU 7-08 PRGs will be used.

Ecologically-based screening levels will be PRGs for evaluating the effectiveness of assembled alternatives in protecting ecological receptors.

The following factors will be considered in the development of PRGs:

- Toxicity information—The toxicity information will be verified with the most recent data available.
- Risk levels—The PRGs will be based on a 1E-04 cancer risk and a noncancer risk to a cumulative hazard index of less than 2. These cleanup goals are at the upper end of the acceptable risk range because conservative exposure parameters, such as a future hypothetical residential land-use scenario, will be used to estimate maximum exposure for risk assessment. In addition, the EPA upper range for carcinogenci risk is 1E-04.
- Other factors—Other factors related to technical limitations (e.g., detection or quantitative limits for specific COCs), as well as factors such as community acceptance, cost, and schedule, will be considered.

5. REMEDIAL INVESTIGATION/FEASIBILITY STUDY TASKS

The end product of the comprehensive RI/FS process under CERCLA is a ROD. The ROD, signed by DEQ, EPA, and DOE, formalizes decisions reached to mitigate and manage risk to human health and the environment associated with WAG 7. The ROD summarizes the results of the RI/FS in support of those decisions. Standard RI/FS tasks have been identified by EPA guidance (EPA 1988) to provide consistent reporting and allow more effective monitoring of RI/FS projects. The general tasks to be carried out as part of the OU 7-13/14 comprehensive RI/FS are listed below:

- Project planning and scoping
- Community relations
- Inventory review and update
- Field investigations
- Sample analysis and data validation
- Data evaluation
- Applicable or relevant and appropriate requirements review
- Feasibility study risk assessment
- Preremedial design investigations
- Development and screening of remedial alternatives
- Detailed analysis of remedial alternatives
- Remedial investigation/feasibility study report
- Proposed plan
- Record of decision.

5.1 Project Planning

During the project-planning step, the types of actions that may be required to address site problems and develop the proper sequence of site activities and investigations are identified. The following describes the plans developed as part of the project planning and scoping task. These plans are consistent with guidelines presented in CERCLA for conducting remedial investigations and feasibility studies (EPA 1988):

- Original *Scope of Work* (Huntley and Burns 1995) and *Work Plan* (Becker et al. 1996)—The initial project strategy is presented in the *Scope of Work*. The strategy was predicated on the assumptions that the OU 7-10 process demonstration interim action would supply data to support the RI/FS and that existing information, in conjunction with information from OU 7-10, would be adequate to develop the OU 7-13/14 comprehensive RI/FS. The *Work Plan* reflects these assumptions. It summarizes and evaluates existing data and information and presents a site description, a project description, a synopsis of previous WAG 7 investigations, original project data quality objectives, the project schedule, and the schedule of deliverables to be generated in the OU 7-13/14 comprehensive RI/FS. Except for monitoring, no additional data collection was planned.

- The *First Revised Scope of Work* (LMITCO 1997) and *First Addendum* (DOE-ID 1998)—Because of subsequent delays in the OU 7-10 process demonstration interim action, DOE-ID, DEQ, and EPA devised an alternate strategy in the *Revised Scope of Work* that was intended to be independent of OU 7-10. The revised strategy included extending the enforceable schedule for completing the RI/FS. The *First Addendum* reevaluated data needs and specified data collection activities. Activities included probing and coring through the buried waste and several treatability studies.

- *Second Revision to the Scope of Work* (Holdren and Broomfield 2003) and this *Second Addendum*—The amended scope and planning process for the OU 7-13/14 comprehensive RI/FS are described in the *Second Revision to the Scope of Work*. Because the FFA/CO enforceable schedule for OU 7-13/14 was modified in the OU 7-10 *Agreement to Resolve Disputes* (DOE 2002), a revised schedule is presented in the *Second Revision to the Scope of Work*. Subsequently, the enforceable schedule was modified again (DOE 2004). This *Second Addendum* was developed to reconsider data needs based on the information that has been collected since the *First Addendum* and to specify the activities that will be conducted to complete the comprehensive RI/FS for OU 7-13/14.

The *Work Plan* addenda were prepared to supplement, not replace, the original *Work Plan*. Generally, components of the *Work Plan* and *First Addendum* that were not revised in this document are not duplicated. Elements of this *Second Addendum*, formulated to meet the objectives of the OU 7-13/14 comprehensive RI/FS, include the following:

- A description of activities completed since the *Work Plan* and the *First Addendum* were published

- *Second Addendum* rationale, including key assumptions for the OU 7-13/14 comprehensive RI/FS, and status of previously defined tasks

- RI/BRA development

- FS development

- Revised RI/FS tasks.

5.2 Community Relations

DOE will conduct the standard community relations activities specified in the INEEL *Community Relations Plan* (DOE-ID 1995) to encourage public involvement in WAG 7 remedial decision-making. However, because of divergent and controversial perceptions surrounding the buried waste at the RWMC, DOE-ID, DEQ, and EPA concur that communicating with stakeholders in advance of public meetings is important. Briefings and other communication avenues will be implemented to allow early opportunities to explain the complexity of cleanup issues and the variety of remedial alternatives that are being considered to manage health and environmental risks posed by the buried waste. Such briefings also will provide a forum to explain the schedule and process that DOE-ID, DEQ, and EPA are following in evaluating the buried waste.

Personnel from the INEEL will execute additional public involvement activities above and beyond those required in the INEEL *Community Relations Plan* (DOE-ID 1995). Representatives from DEQ and EPA will be informed in advance to the extent practicable. Supplemental public involvement and outreach activities may include but are not limited to:

- Community briefings with city councils, county commissions, chambers of commerce, citizens groups, and others with an interest in the remediation of WAG 7
- Tours with the previous groups or the media
- Response to media inquiries
- Development of written materials such as fact sheets, press releases, briefing sheets, response to queries, and information packets
- Development of visual materials such as posters, displays, video productions, Internet sites, and photographs
- Promotional or conference materials such as brochures or presentation slides
- Rental of public meeting rooms or other services necessary to carry out a public function.

5.3 Remedial Investigation/Baseline Risk Assessment Tasks

An RI/BRA report, based on the ABRA (Holdren et al. 2002), will be prepared that summarizes the background information, physical setting, nature, and extent of contamination and baseline risks associated with OU 7-13/14. Risk estimates in the ABRA will be refined in the RI/BRA and applied to the analysis of remedial alternatives in the FS.

For development of the remedial investigation, the first four sections of the ABRA: (1) Introduction, (2) Site Background, (3) Waste Area Group 7 Description and Background, and (4) Nature and Extent of Contamination, will be updated to include revisions to inventory data, waste zone mapping, additional site characterization data from monitoring and probing, and the OU 7-10 Glovebox Excavator Method Project. Density distribution maps of all COCs will be developed for the remedial investigation. Unique waste streams, such as the beryllium blocks and waste similar to spent nuclear fuel, also will be mapped.

The BRA combines the dissolved-phase analysis presented in the ABRA with additional analysis for VOCs to be produced by the OU 7-08 OCVZ Project. The COCs identified in Table 3-1 comprise the complete set of contaminants that will be analyzed and presented in the BRA. The OU 7-08 VOC modeling will account for revised estimates of original VOC inventories and for the mass of VOCs removed from the vadose zone by OCVZ remediation. Additional modeling for the BRA will be performed as described in Section 3.8 and Appendix A.

5.4 Feasibility Study Tasks

Initial development of the FS was completed in the PERA (Zitnik 2002). Development of the FS will focus on (1) reevaluating and revising the assembled alternatives in the PERA considered for detailed analysis, (2) revising the process option evaluation and screening, (3) screening and detailed evaluation of retained alternatives, and (4) developing a balanced comparative analysis. Further analysis of regulations and other guidance to identify ARARs also will be conducted during development of the FS. Preremedial design investigations are being conducted to address technology-specific administrative implementability and effectiveness. Additional fate and transport modeling and risk assessments will be implemented to assess the long-term effectiveness of alternatives analyzed in detail.

5.4.1 Applicable or Relevant and Appropriate Requirements Review

A preliminary survey of regulations that could qualify as ARARs for the OU 7-13/14 comprehensive RI/FS was presented in the *Work Plan* (Becker et al. 1996), duplicated in the *First Addendum*, and updated in the PERA. Further ARAR analysis will be conducted as remedial alternatives are assessed in the FS, as described in Section 4.4. Three types of ARARs will be defined: chemical-, location-, and action-specific. The ARARs will be presented to stakeholders in the proposed plan and finalized in the OU 7-13/14 ROD. In addition to promulgated regulations, to-be-considered measures such as DOE orders also will be analyzed for relevancy. The preliminary ARARs identified to date are presented in Table 5-1.

Table 5-1. Potential chemical-, location-, and action-specific applicable or relevant and appropriate requirements for Waste Area Group 7.

Requirement	Citation	Type[a]
Clean Air Act, National Emissions Standards For Hazardous Air Pollutants	40 CFR 61	A and C
Clean Air Act, National Emissions Standards for Source Categories Criterion	40 CFR 63	A and C
Rules for the Control of Air Pollution in Idaho (Air Toxics Rules)	IDAPA 58.01.01	A and C
Idaho Rules for Public Drinking Water Systems, Safe Drinking Water Act	IDAPA 58.01.08 (40 CFR 141-143)	A and C
Toxic Substance Control Act, Polychlorinated Biphenyls, Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions	40 CFR 761	A, C, and L
Resource Conservation and Recovery Act, Rules and Standards for Hazardous Waste	IDAPA 58.01.05 (40 CFR 260-268)	A, C, and L
Idaho Ground Water Quality Rule	IDAPA 58.01.11	C and L
National Historical Preservation Act	36 CFR 800	L

a. A = action–specific
C = chemical-specific
L = location–specific

CFR = *Code of Federal Regulations*
IDAPA = Idaho Administrative Procedures Act

5.4.2 Preremedial Design Investigations

Preremedial design investigations are being performed to address technology-specific administrative implementability and effectiveness (see Section 4.3). To address administrative implementability, PDSAs and CSEs were completed for ISTD, ISG, and ISV in anticipation that all these technologies would be included in remedial alternatives considered for detailed analysis. However, these studies support eliminating ISV and ISTD during technology and process option screening in the FS.

Technology effectiveness for ISTD and ISG are being addressed by bench-scale tests and by evaluating technologies to treat waste in soil vaults and non-RFP pits and trenches. Techniques to verify the performance of in situ treatment also will be identified and evaluated.

5.4.3 Feasibility Study Risk Assessment

The FS will evaluate short-term and long-term effectiveness of remedial alternatives considered for detailed evaluation (see Section 4.5). Risk assessment methodology for the FS will be developed separately from earlier risk assessments in the IRA and ABRA. Modeling addresses vapor-phase radionuclides (e.g., C-14 and H-3) as well as dissolved-phase COCs.

Risk modeling for the BRA base case will serve as the FS No Action alternative, which will be used as a basis for risk management decisions for WAG 7. Modeling focuses primarily on groundwater exposure pathways, as described in Section 3.8 and Appendix A.

5.4.4 Revised Development and Screening of Alternatives

Much of the planned development and screening of alternatives described in Sections 5.3 and 5.4 of the *Work Plan* (Becker et al. 1996) have been completed and are presented in the PERA (Zitnik et al. 2002), which represents the preliminary development and assembly of remedial alternatives. Potentially applicable technology types and process options were screened through evaluation of technical feasibility, effectiveness, and relative cost in the PERA. The evaluation of technical feasibility included comparison of technology types and the potential effectiveness of process options to (1) handle the areas or volumes of waste to meet remediation objectives, (2) mitigate impacts to human health and the environment during implementation, and (3) perform reliably with respect to COCs and conditions at the site. Results from waste inventory updates, preremedial design investigations, and FS risk assessments will be used to update and refine the evaluations of alternatives in the FS. The alternatives to be considered for detailed analysis in the FS are described in Section 4.1.3 and Appendix A. The following components of the development and screening of alternatives presented in the *Work Plan* were modified:

- Feasibility study assumptions—The FS assumptions documented in the *Work Plan* (Becker et al. 1996) and the *First Addendum* (DOE-ID 1998) were revised to reflect current knowledge and information. A comparison of the *Work Plan* and *First Addendum* assumptions to the revised assumptions for development of the FS is presented in Section 2, Table 2-2. Additional assumptions are included in Appendix A.

- Remedial action objectives—The remedial action objectives for the OU 7-13/14 FS are identified in the PERA and are as follows:

    - Limit the cumulative human-health cancer risk for all exposure pathways to less than or equal to 1E-04

    - Limit the noncancer risk for all exposure pathways to a cumulative hazard index of less than 2 for current and future workers and future residents

    - Inhibit migration of COCs, as identified in the ABRA, into the vadose zone and the underlying aquifer

    - Inhibit exposures of ecological receptors to COCs in soil and waste with concentrations greater than or equal to 10 times background values, resulting in a hazard quotient greater than or equal to 10

    - Inhibit transport of COCs to the surface by plants and animals.

- Preliminary Remediation Goals—The OU 7-13/14 FS will focus on mitigating release of contamination from the source term to prevent future groundwater impacts; actions to remediate the vadose zone and groundwater will not be evaluated. The FS also will address risk from surface pathway exposures. Preliminary remediation goals will be developed for response actions that are protective of human health and the environment. PRGs will be developed using the approach described in Section 4.6 and Appendix A. Final remediation goals will be established in the OU 7-13/14 comprehensive RI/FS ROD.

- Development and screening of alternatives—The remedial technologies and process options that remained after the initial development and screening in the PERA will be revised in the FS to screen out ISV and other in situ technologies for reducing organic contamination in the subsurface, such as ISTD. Alternatives considered for analysis will be revised as described in Section 4.1.3.

5.4.5 Detailed Analysis of Alternatives

Detailed development and evaluation of alternatives remaining after screening will provide information necessary to complete final evaluation and select the preferred alternative. Development information includes the following:

- Components of treatment and disposal technologies will be described to provide an understanding of technology features and functions

- Special engineering considerations required to implement an alternative will be identified through preremedial design investigations

- Methods and costs associated with technical and administrative issues and compliance with ARARs will be discussed

- Operation, maintenance, and monitoring requirements will be addressed (e.g., frequency, complexity, cost, and availability of labor and materials necessary for effective operation of the technologies)

- Safety requirements for implementation of alternatives will be identified for both short-term and long-term operational periods.

Alternatives identified for detailed evaluation and comparative analysis are listed in Section 4.1.3 and Appendix A. The primary focus of continued FS development will be to develop comprehensive descriptions of the identified alternatives and perform detailed evaluations and comparative analysis based on results of safety analysis (see Section 4.3.1), bench-scale studies (see Section 4.3.2), evaluation of ARARs (see Section 4.4), FS risk assessment (see Section 4.5), and additional inventory and characterization data.

5.5 Remedial Investigation/Feasibility Study Documents and Miscellaneous Support

In accordance with the OU 7-10 dispute resolution (DOE 2002), the OU 7-13/14 RI/BRA and FS reports are defined as primary documents. The contents of the ABRA and PERA will be liberally referenced and reproduced in the RI/BRA and FS reports to summarize field investigations, treatability studies, bench-scale studies, technology evaluations, safety analyses, ARARs analysis, and comprehensive and cumulative risk assessments.

Development of the proposed plan, ROD, and miscellaneous support (i.e., community relations activities and maintenance of the Administrative Record) is addressed in Sections 5.6 and 5.7 of the *Work Plan* (Becker et al. 1996).

5.6 Schedule and Milestones

The FFA/CO enforceable schedule for OU 7-13/14 was modified in the *Agreement to Extend Deadlines* (DOE 2004). Planning and implementation for the OU 7-13/14 RI/FS is based on meeting the enforceable schedule presented in Table 5-2.

Table 5-2. Modified Federal Facility Agreement/Consent Order enforceable milestones for Operable Unit 7-13/14 primary documents.

Deliverable	Enforceable Milestone
Draft remedial investigation/baseline risk assessment report—submit to DEQ and EPA	August 2006
Draft feasibility study report—submit to DEQ and EPA	December 2006
Draft record of decision—submit to DEQ and EPA	December 2007

EPA = U.S. Environmental Protection Agency
DEQ = Idaho Department of Environmental Quality

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Appendix A

Modeling for Operable Unit 7-13/14

Appendix A

Modeling for Operable Unit 7-13/14

Following are agreements reached among Department of Energy (DOE), Idaho Department of Environmental Quality (DEQ), and Environmental Protection Agency (EPA) regarding modeling and underlying assumptions for conducting the Operable Unit (OU) 7-13/14 comprehensive remedial investigation/feasibility study (RI/FS). General topics are land use assumptions and exposure scenarios, assembled alternatives for detailed analysis, and model parameters.

A-1. LAND USE ASSUMPTIONS AND EXPOSURE SCENARIOS

Remediation is assumed to occur instantaneously in 2010 for OU 7-13/14 as a basis for establishing the time frame for a hypothetical institutional control period for the RI/baseline risk assessment (BRA) and remediation of the subsurface Disposal Area (SDA). Because of projected closure of the low-level waste pit in 2008 for contact-handled waste and in 2009 for remote-handled waste, 2010 is a reasonable date to use. An additional 100 years of institutional control is assumed to preclude unrestricted access until 2110. Though other decisions for the Idaho National Engineering and Environmental Laboratory (INEEL) use the date 2095 for the end of institutional control, the waste area group (WAG) 7 RI/FS will use 2110. The difference will be explained in the RI/BRA. Though duration periods for remediation vary from approximately 3 to 30 years between alternatives, remediation is assumed to occur instantaneously in 2010 for all alternatives. This assumption provides a common basis for establishing the time frame for a hypothetical institutional control period, evaluating long-term effectiveness, and comparing alternatives for the FS. Land use assumptions and exposure scenarios for the RI/BRA and FS are as follows:

- First 100 years from 2010 through2109: Land use at the Radioactive Waste Management Complex (RWMC) will remain limited to industrial applications with active institutional controls for at least 100 years after remediation. Exposure scenarios and receptor locations for the 100-year time frame from 2010 to 2110 are: current residential at the INEEL boundary (groundwater use only), and current occupational within the current RWMC boundary (inhalation, external exposure, and soil ingestion only). Intrusion into waste will not be quantitatively evaluated for the hypothetical 100-year institutional control period.

- Next 900 years from 2110 to 3010: Assume that land use will remain nonresidential with passive institutional controls (i.e., existing soil cover and land-use restrictions that are not enforced by a physical presence at the RWMC) beyond the first 100 years. Exposure scenarios, receptor locations, and exposure routes for the post-100-year time frame are: residential at the current RWMC boundary (inhalation, external exposure, soil ingestion, crop ingestion, groundwater ingestion, dermal exposure to groundwater) with no intrusion into waste; casual occupational user within the current RWMC boundary (inhalation, external exposure, and soil ingestion only) with no intrusion into waste, and an acute well-construction scenario within the RWMC that intrudes into waste (exposure to contaminated drill cuttings through inhalation, external exposure, and soil ingestion; this scenario does not create a mechanism to contaminate groundwater that must be evaluated).

- Next 9,000 years from 3011 to 12010: Residential groundwater use only at the current RWMC boundary will be evaluated.

A trenching exposure scenario was considered and determined inappropriate for OU 7-13/14. The SDA contains classified waste. All disturbance of the SDA must be reviewed against specific security requirements. These requirements are such that mistaken trenching through a waste area is highly unlikely. The SDA must remain under DOE or other government control after a remediation is selected and implemented for the following reasons:

1. While the Rocky Flats Plant (RFP) waste is now unclassified, there is classified waste in the SDA. Unless that waste is fully retrieved, the SDA must be maintained under a specific set of security controls that can only be maintained though government control.

2. The DOE waste management order requires that DOE maintain control of a radioactive waste landfill until radioactive decay allows unrestricted use. The amount of highly radioactive waste and waste contaminated with TRU elements makes a release unlikely.

3. The record of decision (ROD) will define the specific requirements for future government control. It can be assumed or agreed to by all parties at this time, that government control of the SDA will be a ROD requirement.

In addition, the SDA is not on the utility corridor of the INEEL site, does not support any research activities not related to the management of waste at the SDA, and does not provide support to any other facility area. The location of the SDA close to the Big Lost River precludes its use for a future mission. The area being considered for future reactor development is northeast of INTEC. Therefore, reasons to trench through the SDA in the future are not likely to arise.

A-2. ASSEMBLED ALTERNATIVES

All assembled action alternatives will include continued operation of the vapor vacuum extraction system, passive institutional controls, capping, and long-term maintenance and monitoring. Assembled alternatives are defined to specify scope for the feasibility study and do not represent agreement on remedial decisions for the SDA. Assembled alternatives carried through detailed analysis in the FS will be limited to the following:

- No Action—Duplicate the results of the RI/BRA as a basis for comparison.

- Surface Barrier—Evaluate two caps: an evapotranspiration (ET) cover, and a modified RCRA Type C cover. Two approaches to subsidence—dynamic compaction and foundation grouting—will be evaluated. To quantify long-term effectiveness in the detailed analysis for all alternatives, the ET barrier will be modeled.

- In Situ Grouting (ISG)—Deploy ISG to immobilize contaminants of concern, followed by an ET cap.

- Partial retrieval, treatment, and disposal (RTD)—Retrieve 4 acres of RFP transuranic waste as an example using the Accelerated Retrieval Project approach, and install an ET cap.

- Full RTD—Retrieve up to 1 acre per year average with no more than two, 1/2-acre concurrent retrievals from 2005 through 2035, minus time to install an ET cap and close OU 7-13/14 by 2035, in the following priority: RFP transuranic and alpha-contaminated waste (approximately 17 acres), contact-handled and remote-handled waste (as exposure rates allow) in pits, trenches, and soil vaults (approximately 12 acres), and low-level waste in Pits 17-20 (approximately 6 acres). Use the Accelerated Retrieval Project TRU retrieval approach and assumptions as the basis for estimating short-term risk and cost for RTD of all waste forms, acknowledging in the FS that the basis is not completely representative.

A-2.1 Assumptions and Details for Evaluating Assembled Alternatives

- Human health preliminary remediation goals (PRGs) will be developed only for the post-100-year residential exposure scenario. For VOCs, OU 7-08 PRGs will be used. For ecological PRGs, ecologically based screening level values will be used.

- Though duration periods for remediation vary from approximately 3 to 30 years between alternatives, remediation is assumed to occur instantaneously in 2010 for all alternatives. This assumption provides a common basis for establishing the time frame for a hypothetical institutional control period, evaluating long-term effectiveness, and comparing alternatives for the FS.

- Short-term effectiveness will be evaluated using durations appropriate for the alternative (e.g., approximately 3 years for a Surface Barrier, and 30 years for Full Retrieval).

- Long-term effectiveness for the post-100-year residential exposure scenario at the current RWMC boundary with no intrusion into waste will be modeled as follows:

  - Surface Barrier—groundwater use only at the current RWMC boundary

  - ISG—groundwater use only at the current RWMC boundary

  - Partial RTD—groundwater use only at the current RWMC boundary

  - Full RTD—groundwater use only at the current RWMC boundary

- Long-term ecological risks will be evaluated for the Surface Barrier alternative only.

- Pad A will be incorporated into assembled alternatives as follows:

  - Modified RCRA Type C Surface Barrier—Pad A is left in place and incorporated into the surface barrier

  - ET Surface Barrier—Pad A is removed to the LLW pit without treatment or additional engineering in the pit

  - ISG—Pad A waste is removed, grouted ex situ, and placed in a pit at the SDA

  - Partial RTD—Pad A waste is removed and segregated, TRU waste is sent to WIPP and residual waste is sent to ICDF for treatment and disposal

  - Full RTD—Pad A waste is removed and segregated, TRU waste is sent to WIPP and residual waste is sent to ICDF for treatment and disposed of outside of the INEEL.

- Waste retrieved from pits will be addressed as follows

  - Partial RTD—Retrieved waste is removed from the SDA (e.g., to WIPP or other disposal facility) and the remainder is left in the pits

- Full RTD—TRU to WIPP, remainder to another facility outside of the RWMC.

- Based on additional evaluation subsequent to publication of the *Preliminary Evaluation of Remedial Alternatives* (Zitnik et al. 2001), in situ thermal desorption and all other in situ treatment technologies for volatile organic compounds will be screened out in the feasibility study and eliminated from detailed analysis

- Based on additional evaluation subsequent to publication of the *Preliminary Evaluation of Remedial Alternatives* (Zitnik et al. 2001), in situ vitrification will be screened out in feasibility study technology screening and not carried forward to detailed analysis.

A-2.2 Volatile Organic Compounds

Parameters, modeling, remediation goals, and all other information necessary to evaluate VOCs for the RI/BRA and the FS No Action alternative will be taken from OU 7-08. Assumptions for modeling OU 7-13/14 long-term effectiveness for VOCs in each assembled alternative are as follows:

- Modified RCRA Type C Cap with Shallow Vapor-Vacuum Extraction and no Gas Collection Layer—The infiltration rate through the RCRA cap will be reduced to 0.1 cm/yr. Construction of the cap does not change the release rate of VOCs. Shallow vapor extraction will be simulated by removing the required amount of air from locations (grid blocks) within the model. Extraction locations will be specified in advance and VOC contamination equal to the airflow rate multiplied by the VOC concentration in the grid block will be removed from the model domain. The OCVZ system is assumed to operate until OU 7-08 remediation goals are satisfied.

- ET Cap with an Active Gas Collection Layer—The infiltration rate through the ET cap will be reduced to 0.1 cm/yr. Construction of the cap does not change the release rate of VOCs. To simulate a gas collection layer, no special changes to the model are required because VOCs are not allowed to build up in the gas collection layer. The surface will be modeled as a zero concentration boundary as is the case when there is no cap. The gas collection layer connects with the atmosphere and thus has atmospheric pressure. Barometric influences already are included in the model. The OCVZ system is assumed to operate until OU 7-08 remediation goals are satisfied.

- In Situ Grouting and an ET Cap with a Passive Gas Collection Layer—The infiltration rate through the ET cap will be reduced to 0.1 cm/yr. Implementing ISG will release VOCs as grouting equipment pushes through waste, disrupting and exposing organic sludge. This initial release is assumed to be small and of such short duration that it can be neglected in the model. After grouting, the release rate of VOCs will drop dramatically, which will be modeled by decreasing the diffusion coefficient approximately four orders of magnitude in the release calculation to simulate grout rather than sludge. The OCVZ system is assumed to operate until OU 7-08 remediation goals are satisfied.

- Partial RTD—Additional measures to address VOCs will not be required. The OCVZ system is assumed to operate until OU 7-08 remediation goals are satisfied.

- Full RTD—Additional measures to address VOCs will not be required. The OCVZ system is assumed to operate until OU 7-08 remediation goals are satisfied.

A-2.3 Surface Barriers

For evaluating effectiveness of surface barriers in each assembled alternative, reducing the infiltration rate is the only modification. The effect in the source model will be to reduce release from surface wash and solubility-limited waste streams. Impacts to corrosion and diffusion attributable to reduced infiltration will not be quantified. That is, the same corrosion and diffusion rates will be used, but transport will be constrained because of the lower infiltration rate provided by the cap. This approach is conservative.

A-2.4 In Situ Grouting

Assumptions for modeling long-term effectiveness for the ISG assembled alternative are as follows:

- Points of contact between grout columns may be a zone of weakness where cracks form, release from grout will be simulated by diffusion from within 0.6-m (2-ft) diameter grout columns.
- The surface available for leaching is the outside surface of 0.6-m (2-ft) diameter columns (surface area available for leaching is expected to be much lower, but data are not available to develop accurate prediction of cracking in grouted waste over long periods).
- Infiltrating water flows through columnar joints in the grout at volumetric rates equal to the areal dimensions of the treated region multiplied by the infiltration rate.
- Volumes of water contacting waste in a given period will dissolve the contaminants released in the same period, up to their solubility limits.

Chemical alteration of infiltrating water as it contacts grouted waste will not be evaluated. As a result, release rates in the model might be biased high (conservative). Diffusion coefficients for cement-based grouted contaminants are given in Table A-1.

Table A-1. Cement-based grout diffusion coefficients (cm^2/s).

Contaminant	PERA	FS[a]
Ac-227	1.00E-15	5.00E-08
Am-241	1.00E-15	7.14E-13
Am-243	1.00E-15	7.14E-13
C-14	1.00E-14	2.48E-13
Cl-36	1.00E-10	9.00E-09
H-3	NA[b]	NA[b]
I-129	1.00E-10	9.03E-09
Nb-94	1.00E-10	5.00E-08
Np-237	1.00E-15	1.00E-11
Pa-231	1.00E-15	5.00E-08
Pb-210	1.00E-17	1.00E-11
Pu-238	1.00E-15	1.86E-11

Table A-1 (continued).

Contaminant	PERA	FS[a]
Pu-239	1.00E-15	1.86E-11
Pu-240	1.00E-15	1.86E-11
Ra-226	1.00E-15	3.32E-09
Ra-228	1.00E-15	3.32E-09
Sr-90	1.00E-10	3.32E-09
Tc-99	1.00E-12	3.87E-09
Th-229	1.00E-15	1.50E-11
Th-230	1.00E-15	1.50E-11
Th-232	1.00E-15	1.50E-11
U-233	1.00E-15	1.50E-11
U-234	1.00E-15	1.50E-11
U-235	1.00E-15	1.50E-11
U-236	1.00E-15	1.50E-11
U-238	1.00E-15	1.50E-11
Chromium	NA[b]	NA[b]
Nitrates (as nitrogen)	NA[c]	5.15E-08
Carbon tetrachloride (CCl_4)	NA[d]	1.00E-08
Methylene chloride (CH_2Cl_2)	NA[d]	1.00E-08
Tetrachloroethylene (PCE)	NA[d]	1.00E-08

a. Green shading indicates a change compared to the value used in the PERA based on Riley and Lo Presti (2004)

b. Not applicable. Tritium and chromium were not modeled in the PERA and are not COCs for evaluating grout.

c. Not applicable. A K_d of zero and low infiltration are assumed.

d. Not applicable. Diffusion of VOCs from grout was not modeled for the PERA.

A-2.5 Partial Retrieval, Treatment, and Disposal

The Partial RTD assembled alternative will represent an example scenario involving retrieval of Rocky Flats Plant transuranic waste using the Accelerated Retrieval Project approach. Representatives from the three agencies will identify retrieval areas for evaluation. In addition to the 0.2-ha (1/2-acre) area being retrieved in Pit 4 by the Accelerated Retrieval Project, up to 1.6 ha (4 acres) will be identified, modeled, and evaluated in the FS for long-term effectiveness.

In this scenario, waste forms that contain VOCs, TRU, and uranium are visually identified and removed, with other waste and soil remaining in the pit. To estimate inventories remaining in each source area, the simplifying assumption will be applied that 80% of targeted waste within the defined perimeter of the simulated retrieval area will be removed. Further treatment of retrieval areas will not be required to satisfy preliminary remediation goals.

The Partial RTD alternative also includes retrieving Pad A waste for treatment and disposal at ICDF and an ET surface barrier that incorporates a biotic barrier. No other enhancements to the ongoing vapor-vacuum extraction system to address residual VOCs in the source term will be evaluated under this alternative. The OCVZ system is assumed to operate until OU 7-08 remediation goals are satisfied.

A-2.6 Full Retrieval, Treatment, and Disposal

Assumptions for the Full RTD assembled alternative are as follows:

- For modeling long-term effectiveness, remediation is complete in 2010
- For evaluating all other criteria (e.g., short-term effectiveness, implementability, and cost), remediation is complete in 2035
- The Accelerated Retrieval Project TRU retrieval approach and assumptions provide the basis for estimating short-term risk, acknowledging in the FS that the basis is not completely representative and is nonconservative (i.e., significant short-term risks, such as retrieval of remote-handled waste, will be qualitatively evaluated)
- Strategies will not be developed for ARAR-compliant treating, storing, and disposing of waste with no current path to disposal (e.g., beryllium blocks and other very high-activity waste), but will be qualitatively evaluated
- Cost estimates will be developed as follows:
    - Retrieval of 0.4 ha (1 acre) per year average with no more than two, 0.2-ha (1/2-acre) concurrent retrievals from 2005 through 2035, minus time to complete an ET cap and close OU 7-13/14 by 2035
    - The Accelerated Retrieval Project TRU retrieval approach and assumptions provide the basis for estimating cost for RTD of all waste forms, acknowledging in the FS that the basis is not completely representative and underestimated.

A-3. MODELING RUNS FOR OPERABLE UNIT 7-13/14

A-3.1 Model Characteristics

A-3.1.1 Best-Estimate Inventories

Actual best-estimate inventories through 2009 will be used for all runs except in the BRA upper-bound inventory sensitivity case (see Section A-3.2.2). The Waste Management Program has provided best-estimate inventories for the active LLW pit for 2000 through 2009. All other inventories will be taken from the Waste Inventory Location Database (WILD) documented by McKenzie,[a] which includes information from the following sources:

- Radioisotope inventory updates through 1993 for ANL-W from Carboneau and Vail (2004), INTEC from Vail, Carboneau, and Longhurst (2004), and TAN from Studley et al. (Rev 1 2004)

[a] McKenzie, M. Doug, 2004, *Waste Information and Location Database Update*, ICP/EXT-04-00271, Rev. Draft, Idaho Completion Project.

- Radioisotope inventory updates through 1997 for NRF from Giles and Lengyel[b]

- All inventories for 1994 through 1999 from Little et al. (2001), except for NRF; for NRF 1994 through 1997 from Giles and Lengyel[b] and 1998-1999 from Little et al. (2001)

- RFP VOC inventory updates for CCl_4 from Miller and Varvel (2001) and other VOCs from Varvel (2001). Fifty percent of the original Rocky Flats Plant VOC mass is assumed to remain in the source term (Sondrup et al. 2004)

- All other historical inventory data (e.g., off-Site generators except RFP and small INEEL generators such as ARA and PBF) from the HDT and RPDT (LMITCO 1995a, 1995b; Little et al. 2001).

Estimated contaminant inventories to be removed by the imminent Pit 4 retrieval will be subtracted from the total best-estimate source term. The simplifying assumption will be applied that 80% of targeted waste within the defined perimeter of the simulated retrieval area will be removed.

A-3.1.2 Source Areas

Eighteen source areas will be evaluated, as described in Table A-2.

Table A-2. Subsurface Disposal Area source areas.

Source Area	Description
1	Trenches 1-10
2	Acid Pit
3	Pits 1 and 2, Trenches 11-15
4	Trenches 16-41
5	Pit 3
6	Pit 4
7	Pit 5
8	Trenches 42-58
9	Pit 6
10	Pit 8
11	Pits 7 and 9
12	Pits 10-12
13	Pit 13
14	Pad A
15	Pits 14-16
16	Soil vault rows
17	Pits 17-20 (low-level waste pit, including engineered vaults, through 1999)
18	Actual and projected low-level waste in Pits 17-20, including engineered vaults, from 2000 through 2009

b. Giles, John R., K. Jean Holdren, and Arpad L. Lengyel, 2004, *Estimated Naval Reactors Facility Radiological Inventory from 1952 through 1997 for Waste Area Group 7 (Draft)*, ICP/EXT-04-00296, Idaho Completion Project.

A-3.1.3 Contaminant Groups

Eleven contaminant groups will be evaluated, one for surface exposure pathways only (Group 9) and ten for groundwater and surface exposure pathways, as shown in Table A-3.

Table A-3. Contaminant groups for Operable Unit 7-13/14 simulations.

Simulation Group	Group Name	Contaminants in Group[a]	Description	Basis for Group
Group 1	Am-241	Am-241, Np-237, U-233, and Th-229	Pu-241 decay chain	Neptunium series beginning at Am-241, created by weapons production.
Group 2	Am-243	Am-243, Pu-239, U-235, Pa-231, and Ac-227	Am-243/Pu-239 decay chain	Am-243 to Pu-239, both created primarily by weapons production, to actinium series initiated by U-235.
Group 3	Pu-240	Pu-240, U-236, Th-232, and Ra-228	Pu-240 decay chain	Pu-240 to U-236 created primarily by weapons production to thorium series initiated by Th-232.
Group 4	Pu-238	Pu-238, U-234, Th-230, Ra-226, and Pb-210	Pu-238 decay chain	Pu-238 created by primarily by reactor operations to U-234 to mid-uranium series.
Group 5	U-238	U-238, U-234, Th-230, Ra-226, and Pb-210	Uranium decay chain	Uranium series initiated by U-238 primarily from weapons production.
Group 6	Tc-99	Tc-99, I-129, and Cl-36	Mobile activation products	Created by reactor operations.
Group 7	H-3	H-3	Mobile, dual-phase activation product	Possible model performance indicator. Requires dual-phase simulation. Created by reactor operations.
Group 8	C-14	C-14	Mobile, dual-phase activation product	Requires dual-phase simulation. Created by reactor operations.
Group 9	Nb-94	Nb-94 and Sr-90	Fission and activation products	Surface pathways only. Created by reactor operations.
Group 10	Nitrate	Chromium and Nitrate (as nitrogen)	Toxic chemicals	Nonvolatile (single-phase), nonradioactive chemicals. Chromium is a possible model performance indicator. Nitrate is contained primarily in Series-745 sludge from Rocky Flats Plant. Mobile with no decay.
Group 11	VOC	CCl_4, CH_2CL_2, PCE	Toxic, dual-phase chemicals in organic sludge	Volatile (dual-phase) nonradioactive chemicals. Scaled in ABRA.

a. Simulations include contaminants that are not contaminants of concern. These extraneous contaminants are decay chain products or are useful for other reasons (e.g., comparison to performance assessment modeling and interpreting model performance and uncertainty).

A-3.1.4 Sets of Model Runs

One contaminant group, Group 9, will simulate surface exposure pathways only for Nb-94 and Sr-90. The remaining 10 groups will be modeled using TETRAD. Thirteen sets of TETRAD runs will be completed, six for the RI/BRA and seven for the FS, as described in Sections A-3.3 and A-3.4. With 10 contaminant groups and 13 sets of TETRAD runs, a total of 130 TETRAD simulations will be implemented. One set of runs comprises the following simulations and all supporting pre- and post-processing:

- DOSTOMAN—estimate the average concentrations that could be transported to the surface by plants and animals for all source areas combined
- DUST-MS—run all relevant contaminants for each of 18 source areas to produce input for TETRAD (i.e., flux to the vadose zone)
- TETRAD—run single-phase vadose zone and aquifer transport for seven contaminant groups
- TETRAD—run dual-phase vadose zone and aquifer transport for three contaminant groups.

A-3.2 Model Parameters

A-3.2.1 Distribution Coefficients

Simulations include contaminants that are not contaminants of concern. These extraneous contaminants are decay chain products or are useful for other reasons (e.g., comparison to performance assessment modeling and interpreting model performance and uncertainty). For completeness, distribution coefficients for all contaminants, including extraneous contaminants, are given in Table A-4.

Table A-4. Distribution coefficients (K_ds) for OU 7-13/14 simulations.

Contaminant	ABRA (cm^3/gm or mL/gm)	RI/BRA and FS[a] (cm^3/gm or mL/gm)
Ac-227	4.00E+02	2.25E+02[b]
Am-241	4.50E+02	2.25E+02[b]
Am-243	4.50E+02	2.25E+02[b]
C-14	4.00E-01	1.00E-01
Cl-36	0.00E+00	0.00E+00
H-3	NA[c]	0.00E+00[d]
I-129	1.00E-01	0.00E+00[d]
Nb-94	5.00E+02	5.00E+02
Np-237	8.00E+00	2.30E+01[e]
Pa-231	8.00E+00	8.00E+00
Pb-210	2.70E+02	2.70E+02
Pu-238	5.10E+03	2.50E+03[b]
Pu-239	5.10E+03	0.00E+00[f] and 2.50E+03[b,g,h]

Table A-4. (continued).

Contaminant	ABRA (cm³/gm or mL/gm)	RI/BRA and FS[a] (cm³/gm or mL/gm)
Pu-240	5.10E+03	0.00E+00[f] and 2.50E+03[b,g,h]
Ra-226	5.75E+02	5.75E+02
Sr-90	6.00E+01	6.00E+01
Tc-99	0.00E+00	0.00E+00
Th-229	5.00E+02	5.00E+02
Th-230	5.00E+02	5.00E+02
Th-232	5.00E+02	5.00E+02
U-233	6.00E+00	1.54E+01[e]
U-234	6.00E+00	1.54E+01[e]
U-235	6.00E+00	1.54E+01[e]
U-236	6.00E+00	1.54E+01[e]
U-238	6.00E+00	1.54E+01[e]
Chromium	NA[c]	3.00E+01
Nitrate	0.00E+00	0.00E+00
Carbon tetrachloride	NA[c]	1.00E-03[i] and 2.20E-01[j]
Methylene chloride	NA[c]	1.00E-03[i] and 4.40E-03[j]
Tetrachloroethylene	NA[c]	1.00E-03[i] and 1.82E-01[j]

a. Green shading indicates a change compared to the value used in the ABRA.
b. Based on sieving of interbed material (Hull 2003)
c. Contaminant was not modeled in the ABRA.
d. Riley and Lo Presti (2004)
e. Leecaster and Hull (2004)
f. Mobile fraction source release, surficial sediments, and A-B interbed.
g. Mobile fraction in B-C and C-D interbeds.
h. Nonmobile fraction source release, surface sediments, and interbeds.
i. Volatile organic compounds in basalt.
j. Volatile organic compound in surface sediments and interbeds.

A-3.2.1.1 Plutonium Mobility—Plutonium mobility simulations will be based on Batcheller and Redden (2004). A best-estimate mobile fraction of 3.7% of total Rocky Flats Plant plutonium at time of disposal will be simulated as mobile (colloidal or colloid-sized) using a Kd of 0 mL/g for source release and transport of this fraction to the B-C interbed. The interbed effectively retards the mobile fraction, and subsequent transport will be simulated with a Kd of 2,500 mL/g. The remaining 96.3% of Rocky Flats Plant plutonium and plutonium received from other generators will be simulated with a Kd of 2,500 mL/g. Only Pu-239 and Pu-240 from RFP will be evaluated for facilitated transport. A mobile fraction for Pu-238 will not be evaluated because Pu-238 comprises a small fraction (about 3%) of total plutonium in the SDA.

A-3.2.2 Solubility Limits

Solubility limits are listed in Table A-5.

Table A-5. Solubility limits for OU 7-13/14 modeling (gm/cm³).

Contaminant	ABRA and PERA	RI/BRA and FS[a,b]
Ac-227	NSL[c]	2.05E-12
Am-241	NSL	2.20E-12
Am-243	NSL	2.20E-12
C-14	NSL	1.25E-04
Cl-36	NSL	NSL
H-3	NA[d]	NSL
I-129	NSL	NSL
Nb-94	NSL	7.98E-18
Np-237	NSL	1.10E-03
Pa-231	NSL	1.09E-03
Pb-210	NSL	1.69E-09
Pu-238	NSL	6.15E-15
Pu-239	NSL	6.15E-15
Pu-240	NSL	6.15E-15
Ra-226	NSL	9.83E-09
Ra-228	NSL	9.83E-09
Sr-90	NSL	6.40E-07
Tc-99	NSL	1.59E-02
Th-229	NSL	2.61E-06
Th-230	NSL	2.61E-06
Th-232	NSL	2.61E-06
U-233	NSL	9.12E-07
U-234	NSL	9.12E-07
U-235	NSL	9.12E-07
U-236	NSL	9.12E-07
U-238	NSL	9.12E-07
Chromium	NA[e]	TBD
Nitrates	NSL	NSL
Carbon tetrachloride	NA[f]	8.25E-04
Methylene chloride	NA[f]	2.00E-02
Tetrachloroethylene	NA[f]	2.00E-04

a. Green shading indicates a change compared to the value used in the ABRA and PERA. All changes are based on Riley and Lo Presti (2004).

b. Oxidized conditions are conservatively assumed, though reduced conditions currently prevail in the buried waste. In most cases, the solubility limit was the same for both oxidized and reduced conditions.

c. NSL indicates the contaminant is not solubility limited.

d. Not applicable. Tritium was not modeled in the ABRA and PERA.

e. Not applicable. Chromium was not modeled in the ABRA and PERA.

f. Not applicable. Volatile organic compounds were not modeled for the ABRA and PERA. Instead, values from the Interim Risk Assessment (Becker et al. 1998) were scaled.

A-3.2.3 Corrosion Rates and Fractional Release Rates

Values from the ABRA will be used to represent release from corrosion of activated metal. The ABRA corrosion rates are based on site-specific data from the corrosion test that have been modified to account for magnesium chloride dust suppressant. The volume-to-surface-area ratios are based on values provided in the IMPACTS methodology.

Though zirconium corrodes more slowly than stainless steel, OU 7-13/14 modeling will apply the stainless steel release rate to zirconium for two reasons. First, while the corrosion rate for zirconium is lower, the volume-to-surface area ratio is smaller for zirconium fines; therefore, the release rate would be greater. Second, using one release rate simplifies release calculations.

Alternative values have been proposed by NRF (NR:IBO-98/034). Comparatively, the release rate from the ABRA is lower than the value suggested by NRF for stainless steel and higher than the value suggested for zirconium, as shown in Table A-6. The ABRA showed that release from stainless steel has little impact on the total risk, implying that risk from even slower zirconium release would be even less. However, release rates will be refined if preliminary RI/BRA simulations indicate NRF activated metal waste streams could pose unacceptable risk.

Table A-6. Corrosion rates and volume-to-surface-area ratios.

	Corrosion Rate (in./yr)	Volume–to-Surface-Area Ratio
ABRA	8.75E-06 in/yr[a]	1.87 cm[c]
NRF stainless	2.1E-05 in/yr[b]	1.83 cm[b]
NRF zirconium	2.6E-06 in/yr[b]	NA[d]

a. From Adler-Flitton et al. (2001)

b. From NR:IBO-98/034

c. From NUREG/CR-4370

d. Not applicable -- assumed to be fines

Annual fractional release rates based on corrosion rates and volume-to-surface-area ratios are provided in Table A-7.

Table A-7. Annual fractional release rates[a] (1/yr)

Contaminant	RI/BRA and FS[a]	NRF[b]
Ac-227	1.19E-05	3.35E-05
C-14	1.19E-05	3.35E-05
C-14 in beryllium	2.65E-03	NA
Cl-36	1.19E-05	3.35E-05
H-3	2.65E-03	NA
Nb-94	1.19E-05	3.35E-05
Sr-90	1.19E-05	3.35E-05

a. From the ABRA (Holdren et al. 2002)

b. The annual fractional release rate is the corrosion rate divided by the volume-to-surface area ratio.

A-3.3 Remedial Investigation Baseline Risk Assessment Model Runs and Sensitivity Analysis

A-3.3.1 BRA Base Case Runs (1 set)

Modeling for the BRA (synonymous with FS No Action scenario) will incorporate the following characteristics:

- Updated lithology (Ansley, Helm-Clark, and Magnuson 2004) and aquifer domain (Rohe 2003 letter report[c])
- All beryllium blocks are grouted
- Pit 4 retrieval of 0.2 ha (1/2 acre) is completed with part of the TRU, uranium, and VOC inventories removed and the remainder left in the pit
- Variable infiltration across the SDA with a net average of 5 cm/yr (2 in./yr) and a 1.0 cm/yr (0.4 in./yr) background infiltration rate (assume 2004 contouring does not significantly affect infiltration rates)
- Best-estimate inventory through 2009 (see Section A-3.1.1)
- Mobile fraction of 3.7% of RFP Pu-239 and Pu-240.

A-3.3.2 BRA Sensitivity Runs (5 sets)

For BRA sensitivity cases, all parameters for the BRA base case will be held constant except for the parameter being evaluated for sensitivity. The following sensitivity cases will be modeled using DUST-MS and TETRAD:

- Upper-bound inventory (historical and revised upper bounds from sources listed in Section A-3.1.1, total curies allowed for the active LLW pit (modified to be physically feasible), 75% of the original mass of VOCs still in the source term, and an upper-bound 4.9% mobile fraction for RFP plutonium)
- Infiltration—upper bound of 23 cm/yr (9 in./yr) applied uniformly across the SDA, and unchanged background infiltration of 1.0 cm/yr (0.4 in./yr)
- Infiltration—unchanged variable infiltration with a net average of 5 cm/yr (2 in./yr), and reduced background infiltration of 0.1 cm/yr (0.04 in./yr)
- Pit 4 inventory not removed and beryllium blocks not grouted (limit to relevant contaminant groups in Table A-3, involves VOC dual-phase and C-14 dual continuum runs)
- B-C interbed eliminated, colloidal and colloidal-sized plutonium is modeled with a zero K_d down to the C-D interbed (limit to contaminant Groups 2 and 3 in Table A-3).

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c. Rohe, M. J., March 9, 2004, Interoffice Memorandum to S. O. Magnuson and T. J. Meyer, "OU 7-13/14 ABRA Saturated Groundwater Model Update," Idaho National Engineering and Environmental Laboratory.

A-3.3.3 RI/BRA Sensitivity Analysis

No additional sensitivity analyses are identified.

A-3.4 Feasibility Study Model Runs and Sensitivity Analysis

A-3.4.1 Preliminary Remediation Goals

Preliminary remediation goals (PRGs) will be developed using methodology presented in Nitschke et al. 2004. A combination of GWSCREEN runs and risk estimates produced by scaling (i.e., multiplying the BRA risk estimate times technology flux divided by BRA flux) will be used to develop human health PRGs, which will be calculated for the hypothetical future residential scenario only. For carbon tetrachloride, methylene chloride, and tetrachloroethylene, OU 7-08 PRGs will be used.

Ecologically based screening levels will be PRGs for evaluating the effectiveness of assembled alternatives in protecting ecological receptors.

A-3.4.2 FS Model Runs (5 sets)

The BRA base case (see Section A-3.3.1) is synonymous with the FS No Action alternative. Using the same characteristics specified in Section A-3.2, FS runs will incorporate achievable release parameters that meet or exceed preliminary remediation goals. The following assembled alternatives will be simulated:

- Modified RCRA Type C Surface Barrier – Pad A is left in place and incorporated into the surface barrier; infiltration rate of 0.1 cm/yr (0.04 in./yr) with background infiltration of 1.0 cm/yr (0.4 in./yr); additional shallow VVE is integrated into the OU 7-08 system

- ET Surface Barrier – Waste is retrieved from Pad A and transferred to the LLW pit without treatment or additional engineering in the pit; infiltration rate of 0.1 cm/yr (0.04 in./yr) with background infiltration of 1.0 cm/yr (0.4 in./yr); cap includes a biotic barrier and an active gas collection system that is integrated into the OU 7-08 system

- ISG – ISG selected areas based on COCs; waste from Pad A is retrieved, treated ex situ, and returned to a pit in the SDA; ET surface barrier includes a biotic barrier and passive gas collection layer

- Partial RTD—Remove 1.6 ha (4 acres) as an example, targeting VOCs and TRUs; waste from Pad A is retrieved and sent to ICDF for treatment and disposal; and ET surface barrier with a biotic barrier

- Full RTD—Remove all waste; waste from Pad A is retrieved, sent to ICDF for treatment, and disposed of outside of the INEEL; ET surface barrier with no gas collection layer or biotic barrier.

A-3.4.3 FS Sensitivity Runs (2 sets)

For FS sensitivity cases, all parameters for the FS case will be held constant except for the parameter being evaluated for sensitivity. The following sensitivity cases will be modeled using DUST-MS and TETRAD:

- ET surface barrier with 1.0 cm/yr (0.4 in./yr) infiltration rate (instead of 0.1 cm/yr [0.04 in./yr]) and an unchanged background infiltration rate of 1.0 cm/yr (0.4 in./yr)

- Full RTD with no cap.

A-3.4.4 FS Preliminary Remediation Goals and Sensitivity Analysis

Additional FS sensitivity analysis will be based on flux from the source term into the vadose zone. Risk estimates will be scaled by multiplying the BRA (or relevant FS case) risk estimate times sensitivity-case flux divided by BRA (or relevant FS case) flux. Only one sensitivity case is identified and will be evaluated: ISG with upper-bound release rate.

A-3.5 Ecological Risk Assessment

Ecological risk assessment will comprise updating results from the ABRA. Average contaminant concentrations across the SDA based on revised inventories will be calculated using DOSTOMAN. These concentrations will be compared to ecologically based screening levels for WAG 7. Ecological COCs will be identified based on an HQ greater than or equal to 10 for contaminants that exceed background soil concentrations by a factor of at least 10.

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Appendix B

Corrections to Risk Estimates in the Ancillary Basis for Risk Analysis

Appendix B

Corrections to Risk Estimates in the Ancillary Basis for Risk Analysis

B-1. INTRODUCTION

Since publication of the *Ancillary Basis for Risk Analysis of the Subsurface Disposal Area* (Holdren et al. 2002), errors have been discovered that slightly affect the predicted risk results. The errors were related to inventories for C-14 and Cl-36, the corrosion rate applied to stainless steel, the interface between the source release model and the flow and transport model, and the implementation of spatially varying permeabilities in the interbeds. This appendix describes these errors and presents the results of additional simulations using models from *Ancillary Basis for Risk Analysis* (ABRA) (Holdren et al. 2002) that calculate risks, with the corrected (1) inventories, (2) interface between source and flow and transport model, and (3) interbed permeabilities. These models also verify the scaling method proposed for correcting the interface error. Lastly, updated risks are presented for all contaminants that were simulated in the ABRA.

B-2. INVENTORY AND CORROSION RATE ERRORS

The ABRA lists 92.6 Ci of C-14 and 0.66 Ci of Cl-36 as disposed of as activated metal in beryllium blocks. This beryllium block inventory makes up 18.5% and 59.9% of the total inventory for C-14 and Cl-36, respectively. Beryllium is simulated to have a high corrosion rate, and both C-14 and Cl-36 show significant predicted future risks from the beryllium waste stream. Upon review of ABRA results, inventory for the 1993 disposal of beryllium in a soil vault row was not included in the total inventory in the ABRA. As the inventory was being corrected in the release simulations, it was determined that there was an additional error in the C-14 and Cl-36 simulations. The high beryllium-corrosion rate was used for the stainless steel waste stream in the years when beryllium was disposed of. The total effect on the risk results was uncertain as the errors are, to some extent, compensating. A total of 128 Ci of C-14 was simulated in the ABRA as if it were being released from beryllium blocks. Therefore, a simulation that uses the inventory in the beryllium block contained in the *Beryllium Waste Transuranic Inventory in the Subsurface Disposal Area, Operable Unit 7-13/14* (Mullen et al. 2003) was used along with the corrected corrosion rates for the stainless steel. The correct inventory for C-14 and Cl-36 in beryllium blocks is 92.4 Ci and 0.88 Ci, respectively. All simulated risk results presented in this appendix include inventory and corrosion rate corrections.

B-3. SOURCE RELEASE MODEL TO FLOW AND TRANSPORT MODEL INTERFACE ERROR

During FY 2003, the Organic Contamination in the Vadose Zone Project updated volatile organic fate and transport modeling to use the same model as that used for the ABRA. During this process, an error was discovered in the modeling interface that transferred fluxes from the source release model and assigned them as internal sources in the ABRA flow and transport model, hereafter called the vadose zone model. This error increased the mass of contaminants input into the vadose zone model, thereby overestimating simulated concentrations for the groundwater pathway. The results were affected by up to an approximate factor of two. This subsection presents a detailed explanation of the error and estimates the impacts on the ABRA base-case simulated risks.

The DUST-MS source release model estimated a mass flux for each contaminant for each of thirteen source areas. DUST-MS is a one-dimensional model and calculates the total mass flux for each source area. These DUST-MS total mass flux rates are modified for use in the vadose zone model by dividing each total mass flux rate by the number of vadose zone model grid blocks representing each source area. The error in this interface occurred because the total number of grid blocks per source area was inconsistent between the source model where the flux was calculated and the vadose zone model where the flux was applied. Table B-1 shows the number of grid blocks for each area that were used in the source model and in the vadose zone model. As can be seen in the table, the vadose zone model always had a larger number of grid blocks. Therefore, with a larger number of grid blocks, more mass was input into the vadose zone model than should have been. The last column in the table is a factor representing the amount of additional mass applied per source area.

Table B-1. Number of simulated grid blocks in source model and vadose zone model.

Source Area	Source Model	Vadose Zone Model	Additional Mass Error Ratio
Trenches 1-10	22	30	1.364
Pits 1 and 2	24	33	1.375
Pit 3	5	9	1.800
Pit 4	26	34	1.308
Pit 5	26	46	1.769
Pit 6	9	11	1.222
Pit 8	7	9	1.286
Pit 9	9	13	1.444
Pit 10	21	30	1.429
Pad A	5	9	1.800
Low-level waste	16	29	1.812
Low-level waste projected	13	22	1.692
Soil vaults	26	35	1.346

This interface error affects only the groundwater pathway. The magnitude of the error on predicted groundwater risks was calculated by the following process. Each grid block error ratio was multiplied by its respective inventory for each source area (using Table 5-8 in the ABRA). These adjusted source areas were then summed to get the total inventory that was actually applied in the vadose zone model. The derived-inventory-scale factor was then the total vadose zone model inventory divided by the source model inventory. Since transport simulation is linear, the revised simulated risks then can be approximated by dividing the ABRA risks by the derived-inventory-scale factors. Table B-2 shows the derived-inventory-scaling factors for the groundwater portion of the risk for each contaminant simulated in the ABRA. Risks from volatile organic compounds were scaled from earlier modeling results and were not affected by this interface error.

Table B-2. Source model inventories, vadose zone model inventories, and derived inventory-scale factors for adjusting risk on an individual contaminant basis.

ABRA Simulation Group	Contaminant	Source Model Inventory (g)	Vadose Zone Model Inventory (g)	Derived Inventory Scale Factor for Groundwater Ingestion Risk
1	Am-241	5.32E+04	7.78E+04	1.46
	Np-237	3.75E+03	6.74E+03	1.80
	U-233	1.56E+02	2.29E+02	1.47
	Th-229	3.20E-05	5.75E-05	1.80
2	Am-243	6.74E+02	1.22E+03	1.81
	Pu-239	1.04E+06	1.56E+06	1.49
	U-235	2.56E+06	3.95E+06	1.54
	Pa-231	2.08E-02	3.77E-02	1.81
	Ac-227	7.08E-09	1.28E-08	1.81
3	Pu-240	7.53E+04	1.16E+05	1.54
	U-236	4.42E+04	7.31E+04	1.65
	Th-232	1.23E+07	1.96E+07	1.59
	Ra-228	3.96E-08	7.17E-08	1.81
4	Pu-238	9.99E+02	1.77E+03	1.77
	U-234	0.00E+00	0.00E+00	a
	Th-230	0.00E+00	0.00E+00	a
	Ra-226	0.00E+00	0.00E+00	a
	Pb-210	0.00E+00	0.00E+00	a
5	U-238	3.48E+08	5.43E+08	1.56
	U-234	1.08E+04	1.63E+04	1.51
	Th-230	1.55E+00	2.46E+00	1.59
	Ra-226	6.06E+01	9.64E+01	1.59
	Pb-210	6.68E-09	1.21E-08	1.81
6	Nitrate	1.03E+09	1.66E+09	1.61
7	Tc-99	3.56E+03	6.18E+03	1.74
	I-129	8.94E+02	1.58E+03	1.77
	C-14	1.12E+02	1.69E+02	1.51
	Cl-36	3.35E+01	6.06E+01	1.81
	Nb-94	5.36E+03	9.60E+03	1.79

a. The decay chain products of Pu-238 in Simulation Group 4 were all caused by ingrowth and were scaled based on the Pu-238 derived-scale factor.

ABRA = *Ancillary Basis for Risk Analysis* (Holdren et al. 2002)

B-4. ADDITIONAL SIMULATIONS WITH ADJUSTED INVENTORIES AND WITHOUT THE INTERFACE ERROR

This section presents simulation results using the ABRA source and vadose zone models with inventory corrections for C-14 and Cl-36 and the correct number of grid blocks in the interface between the source release and the vadose zone models. Two contaminant groups were selected for updated simulations to compare against the ABRA base case: Group 5 (U-238, U-234, Th-230, Ra-226, and Pb-210) and Group 7 (Tc-99, I-129, C-14, and Cl-36). Group 5 was selected to verify the appropriateness of the method derived in Section B-3 to scale the ABRA risks. Group 7 was selected both to verify the scaling method for Tc-99 and I-129 and to update the ABRA risks with the corrected inventories for C-14 and Cl-36.

Table B-3 shows the Group 5 ABRA maximum risks for the 1,000-year simulation period for a hypothetical residential scenario, the scaled ABRA risks using the derived groundwater pathway scale factors from Table B-2, and the risk results for the updated simulation. Table B-3 shows the total risk including the scaled or corrected groundwater ingestion pathway risk. The risks for U-234, Th-230, Ra-226, and Pb-210 in Table B-3 are for Simulation Group 5 only and do not include the contribution to the risk from ingrowth in Group 4. Comparing the scaled ABRA risks to the updated risks showed that the scaled ABRA risks were all less than or roughly equivalent (i.e., to one significant figure) to the updated risks. This indicated the scaling method was reasonably close in estimating the magnitude of the correction for the Group 5 contaminants.

Table B-3. Group 5 simulation results.

Contaminant	ABRA Risk	Scaled ABRA Risk	Updated Simulation Risk
U-238	3E-03	2E-03	2E-03
U-234	1E-03	9E-04	1E-03
Th-230	6E-07	4E-07	4E-07
Ra-226	3E-06	2E-06	3E-06
Pb-210	4E-07	2E-07	3E-07

ABRA = *Ancillary Basis for Risk Analysis* (Holdren et al. 2002)

Table B-4 shows similar risk information for the updated Group 7 simulation. As a reminder, the updated simulation risks included the inventory corrections for C-14 and Cl-36 and the correct interface between the source model and the vadose zone model. For the Tc-99 and I-129, the scaled ABRA risks just slightly underpredicted the risks from the updated simulation, illustrating the validity of the scaling method for revising the ABRA risks to account for the interface error. Even with the inventory corrections, the C-14 risks are comparable between the scaled ABRA results and the updated simulation. The Cl-36 risks were greater from the updated simulation than from scaling the ABRA. The ABRA Cl-36 risk increased from 6E-06 to 1E-05. This increase identifies Cl-36 as a contaminant of concern (COC) for the remedial investigation/feasibility study according to the criteria in the ABRA.

Table B-4. Group 7 simulation results.

Contaminant	ABRA Risk	Scaled ABRA Risk	Updated Simulation Risk
Tc-99	4E-04	2E-04	3E-04
I-129	6E-05	3E-05	4E-05
C-14	6E-04	4E-04	5E-04
Cl-36	6E-06	4E-06	1E-05

ABRA = *Ancillary Basis for Risk Analysis* (Holdren et al. 2002)

In conclusion, the scaling method derived in Section B-3 worked correctly to revise the ABRA risks to account for the interface error. This scaling method is used in the last section to update the risks for the remainder of the contaminants that were simulated in the ABRA.

B-5. ADDITIONAL SIMULATIONS WITH CORRECTED SPATIALLY VARIABLE INTERBED PERMEABILITIES

Another error discovered since publication of the ABRA in the process of developing corrections in this appendix was related to assignment of spatially variable permeabilities in the B-C and C-D interbeds. In the ABRA, these permeabilities were taken from results documented in Leecaster (2002). The same interface processor was used to implement spatially variable permeabilities, porosities, interbed top surface elevations, and interbed thickness into the TETRAD simulations. However, the format in which the permeabilities were supplied to this interface processor was different than that for the permeabilities, interbed elevations, and interbed thickness. The permeabilities were supplied by columns of the grid matrix beginning at the southwest corner, while the other three data sets were supplied by rows beginning at the southwest corner. This can be seen in Figures 5-12 and 5-13 of the ABRA where the kriged porosities show agreement with the measured porosity values, while the kriged permeabilities do not show agreement with the measured permeability values. The simulation results presented in Section B-4 of this appendix included these incorrect permeabilities.

A simulation was conducted with the spatially variable permeabilities correctly implemented for the B-C and C-D interbed. Contaminant Group 7 (i.e., Tc-99, I-129, C-14, and Cl-36) was selected to compare against the case presented in Section B-4 of this appendix. Table B-5 shows that simulated risks were unchanged to one significant figure when corrected spatially variable interbed permeabilities were included. Both sets of risk results in Table B-5 are based on the conceptual model that a low-porosity, low-permeability feature is present everywhere at the tops of the B-C and C-D interbeds. As long as this feature is included, values assigned for permeability of the remainder of the interbed appear to have only secondary importance. This low-porosity, low-permeability feature serves to equalize the influence of advective transport because all contaminants have to pass through it. Thus, the important feature of the conceptual model is implemented for representing flow and transport in the vadose zone.

Table B-5. Group 7 simulation results comparison between incorrectly and correctly implemented, spatially variable permeabilities.

Contaminant	Section B-4 Updated Simulation Risks with Incorrect Interbed Permeabilities	Updated Simulation Risks with Corrected Interbed Permeabilities
Tc-99	3E-04	3E-04
I-129	4E-05	4E-05
C-14	5E-04	5E-04
Cl-36	1E-05	1E-05

B-6. UPDATED ANCILLARY BASIS FOR RISK ANALYSIS RISK RESULTS

Updated ABRA risk results were calculated using the scaling method developed in Section B-3. Table B-6 provides the updated risk estimates for the total risk for all contaminants. The volatile organic compounds are replicated from the ABRA for completeness. The shading on Table B-6 is the same as that used in Table 7-1 in the ABRA and indicates those isotopes with risk estimates greater than 1E-05 and 1E-04. The major effect of the inventory correction was that Cl-36 becomes a COC. For contaminants that did not have the inventory correction, the revised risk decreased when the scale factors were applied. The risks generally did not change enough to affect where they fell in relation to the order of magnitude boundaries used to identify COCs. The exceptions were U-235, U-236, and nitrate. The U-235 risk became smaller than 1E-04 where it was previously larger. The U-236 risk was essentially just at 1E-04 in the ABRA and became smaller when scaling was applied. Nitrate was also right at the limit of acceptability and became less than the limit. Figure B-1 shows the total risk for all radioactive contaminants and is similar to Figure 7-2 in the ABRA. The differences in the plotted curves shown in Figure 7-2 (in the ABRA) and Figure B-1 for various groups of COCs have two causes: (1) Figure 7-2 does not include the Sr-90 risk and (2) Figure B-1 does not account for either the receptor location moving from the boundary of the INEEL to the boundary of the SDA or the end of the simulated institutional control period.

In conclusion, the interface error that occurred in developing the ABRA results was unfortunate; additional modeling for the FS will be carefully checked. However, cumulative risk is summed across all exposure routes, and thus the magnitude of the error was not significant. The scaled ABRA results in Table B-6 or results of feasibility study No Action simulations will be incorporated into the Operable Unit 7-13/14 remedial investigation/baseline risk assessment. When comparing to the ABRA results, only the groundwater pathway is scaled. The groundwater ingestion component of total risk is very small for those contaminants with risk dominated by surface pathway exposures (e.g., Pu-239, Pu-240, and Sr-90); therefore, when summed, the very small groundwater risk does not affect cumulative risk. For example, the sum of 1E-08 and 1E-05 is rounded from 1.001E-05 to 1E-05.

Table B-6. Identification of contaminants of concern and 1,000-year peak risk estimates for a hypothetical future residential exposure scenario.

Contaminant	Note[a]	Peak Risk	Year	Peak Hazard Index	Year	Primary 1,000-Year Exposure Pathway
Ac-227	**7**	1E-06	3010[b]	NA	NA	Groundwater ingestion
Am-241	**1,3,7**	**3E-05**	2953	NA	NA	Soil ingestion, inhalation, external exposure, and crop ingestion
Am-243	**7**	4E-08	3010[b]	NA	NA	External exposure
C-14	**1,4,8**	**5E-04**	2278	NA	NA	Groundwater ingestion
Cl-36	**8**	1E-05	2110	NA	NA	Groundwater ingestion
Cs-137	**7**	5E-06	2110	NA	NA	External exposure
I-129	**1,3,8**	**4E-05**	2110	NA	NA	Groundwater ingestion
Nb-94	**1,3,7**	**8E-05**	3010[b]	NA	NA	External exposure
Np-237	**1,4,7**	**2E-04**	3010[b]	NA	NA	Groundwater ingestion
Pa-231	**7**	2E-06	3010[b]	NA	NA	Groundwater ingestion
Pb-210	**7**	4E-07	3010[b]	NA	NA	Soil and crop ingestion
Pu-238	**2,8**	**1E-09**	2286	NA	NA	Soil and crop ingestion
Pu-239	**2,7**	**2E-06**	3010[b]	NA	NA	Soil and crop ingestion
Pu-240	**2,7**	**2E-06**	3010[b]	NA	NA	Soil and crop ingestion
Ra-226	**8**	3E-06	3010[b]	NA	NA	External exposure
Sr-90	**1,4,7**	**1E-04**	2110	NA	NA	Crop ingestion
Tc-99	**1,4,8**	**3E-04**	2110	NA	NA	Groundwater ingestion and crop ingestion
Th-229	**7**	2E-07	3010[b]	NA	NA	Groundwater ingestion
Th-230	**7**	5E-07	3010[b]	NA	NA	Groundwater ingestion
Th-232	**7**	1E-09	3010[b]	NA	NA	Crop ingestion
U-233	**1,3,7**	**2E-05**	3010[b]	NA	NA	Groundwater ingestion
U-234	**1,4,8**	**1E-03**	3010[b]	NA	NA	Groundwater ingestion
U-235	**1,4,7**	**8E-05**	2662	NA	NA	Groundwater ingestion
U-236	**1,4,7**	**6E-05**	3010[b]	NA	NA	Groundwater ingestion
U-238	**1,4,8**	**2E-03**	3010[b]	NA	NA	Groundwater ingestion
Carbon tetrachloride	**1,5**	**2E-03**[c]	2105	**5E+01**[c]	2105	Inhalation and groundwater ingestion
Methylene chloride	**1,3**	**2E-05**[c]	2185	1E-01[c]	2185	Groundwater ingestion
Nitrates	**1,6**	NA	NA	**7E-01**	2120	Groundwater ingestion
Tetrachloroethylene	**1,6**	NA	1952	**1E+00**[c]	2137	Groundwater ingestion and dermal exposure to contaminated water

1. **Green** = the contaminant is identified as a human health contaminant of concern in the *Ancillary Basis for Risk Analysis of the Subsurface Disposal Area* (Holdren et al. 2002) based on carcinogenic risk greater than 1E-05 or a hazard index greater than or equal to 1 contributing to a cumulative hazard index greater than 2.
2. **Brown** = plutonium isotopes are classified as special-case contaminants of concern to acknowledge uncertainties about plutonium mobility in the environment and to reassure stakeholders that risk management decisions for the Subsurface Disposal Area will be fully protective.
3. **Blue** = carcinogenic risk between 1E-05 and 1E-04 in the *Ancillary Basis for Risk Analysis* (ABRA) (Holdren et al. 2002).
4. **Red** = carcinogenic risk greater than 1E-04 in the ABRA.
5. **Pink** = toxicological (noncarcinogenic) hazard index greater than or equal to 1 in the ABRA.
6. Gray = results from modeling based on inventory corrections indicate Cl-36 risk is 1E-05.
7. Scaled risk value.
8. Risk value from simulation corrected for interface error between source model and flow and transport model.

a. Notes: For toxicological risk, the peak hazard index is given, and for carcinogenic probability, the peak risk is given.
b. The peak groundwater concentration does not occur before the end of the 1,000-year simulation period. Groundwater ingestion risks and hazard indices were simulated for the peak concentration occurring within 10,000 years and are not presented in this table.
c. The risk estimates were produced by scaling results from the *Interim Risk Assessment and Contaminant Screening for the Waste Area Group 7 Remedial Investigation* (Becker et al. 1998) based on inventory updates.

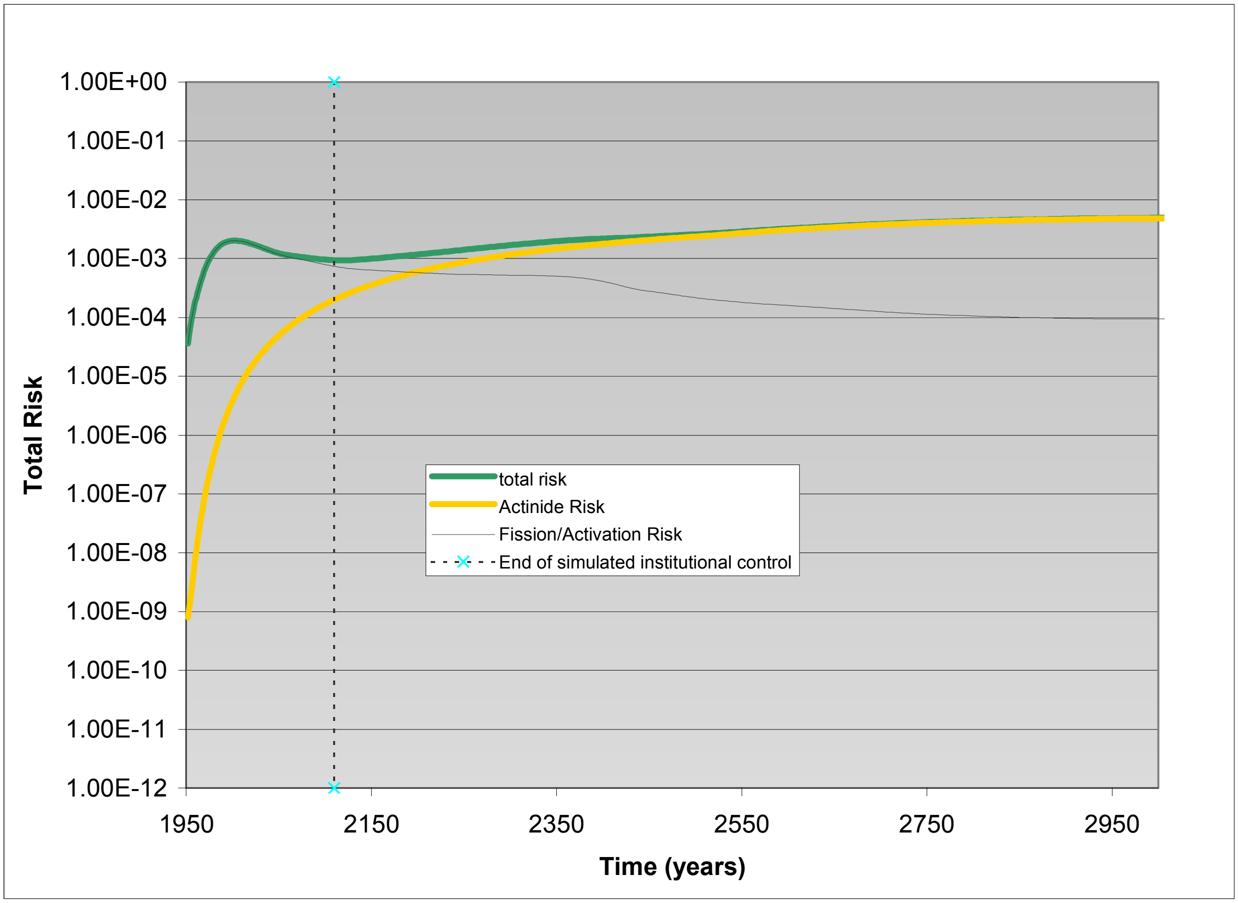

Figure B-1. Total risk from radionuclides.

B-7. REFERENCES

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Appendix C

Flow and Transport Model Evaluation

Appendix C

Flow and Transport Model Evaluation

C-1. INTRODUCTION

This report documents the evaluation and selection of preferred groundwater modeling software for simulating contaminant fate and transport for the Waste Area Group (WAG) 7 Operable Unit (OU) 7-13/14 comprehensive remedial investigation/feasibility study. The document is divided into six sections as follows: Section C-1 introduces the topic, Section C-2 provides the purpose and scope, Section C-3 presents the motivation for performing the software evaluation task, Section C-4 identifies the criteria and potential software chosen for evaluation and presents a comparison of codes against these criteria, Section C-5 summarizes the findings and presents the preferred software, and Section C-6 lists documents referenced in this report.

C-2. PURPOSE AND SCOPE

The purpose of this exercise was to select a software package or several packages that best solve the contaminant fate and transport simulation needs of the WAG 7 baseline risk assessment and remediation efforts. The purpose of this exercise was not to verify or validate the operational status of the software but to consider each software package for its applicability to the Subsurface Disposal Area (SDA).

This report documents the evaluation and selection of the preferred groundwater modeling software tool for OU 7-13/14. Selected groundwater flow and transport simulator capabilities are compared against required and desired features for simulating water flow and contaminant transport at the SDA. These required features are largely based on the criteria established in the *Work Plan for Operable Unit 7-13/14 Waste Area Group 7 Comprehensive Remedial Investigation/Feasibility Study* (Becker et al. 1996).

C-3. MOTIVATION

The TETRAD (Vinsome and Shook 1993) simulator has been used extensively for simulating flow and transport for WAG 7 OU 7-13/14 since 1995. Limitations of this simulator that warrant a search for a more suitable software package have been identified over time. Limitations of the TETRAD software are discussed in the remainder of this section. Some of these identified limitations are being addressed in ongoing Laboratory-Directed Research and Development Program projects, and, therefore, the TETRAD code was reevaluated as part of this effort. A similar code-selection effort was initiated by WAG 3 approximately 1 year ago but was never published. This effort uses the unfinished results of that exercise.

The model evaluation weighs the time and costs involved with using a new simulator because considerable time, effort, and expense have been expended using the TETRAD simulator at the Idaho National Engineering and Environmental Laboratory (INEEL). However, improvements occur in a dynamic field such as environmental flow and transport modeling, and it behooves WAG 7 to use the best tool available.

C-3.1 Scaling Effect Limitation

TETRAD software treats dissolved-phase contaminants as a separate water component and tracks their movement as if the contaminants are a portion of the total water mass. For cases in which the contaminant concentration is very low (dissolved radionuclides), the contaminant mass must be scaled up from one to 10 orders of magnitude to result in a large enough simulated mole fraction to track mass while still maintaining a small enough mole fraction as to not affect the water-pressure field. The amount of scaling necessary gets further complicated when contaminants sorb and their mass fraction gets reduced. Effort is necessary to ensure that the equivalent volume mass change caused by sorption also does not affect the water-pressure field.

In some simulation codes, the conservation equations for component mass and energy are solved simultaneously, and the solute conservation equations are solved sequentially after the coupled flow equations. This decoupling of flow and transport allows accurate transport solutions even at very low environmental concentrations.

C-3.2 Computational Intensity Limitation

The compositional simulation approach on which TETRAD is based requires specification of a small mass convergence criterion to track the small amounts of contaminant mass accurately when simulating low-concentration radionuclide transport. The criterion leads to computationally intensive simulations that result in long simulation times on the order of weeks to months. This has in part been mitigated by using more and faster central processing units.

C-14 has been identified as a potential contaminant of concern in the *Interim Risk Assessment and Contaminant Screening for the Waste Area Group 7 Remedial Investigation* (Becker et al. 1998) and again in the *Ancillary Basis for Risk Analysis of the Subsurface Disposal Area* (Holdren et al. 2002). Carbon-14 moves in both aqueous and gaseous phases. When simulating vapor-phase transport of contaminants for the SDA, it has been necessary in the past and will continue to be necessary in the future to use a dual-continuum approach to account for storage and release of contaminants in the matrix portion of the fractured basalts and to account for vapor-phase diffusional releases to land surface. The dual-continuum approach will increase the computational burden even further. It is unknown whether simulating dual-continua transport of C-14 will be feasible with the current model implementation developed in the *Ancillary Basis for Risk Analysis* (Holdren et al. 2002). The *Ancillary Basis for Risk Analysis* implementation only used a single-continuum approach, which only considered the fractures in the fractured basalt portions of the subsurface. The code-selection exercise will attempt to identify a code with a better chance of being able to complete these simulations while incorporating the level of detail desired for the subsurface.

C-3.3 Mass Balance Accounting Limitation

TETRAD internally maintains a mass balance error to the tolerance specified by the user. However, the reporting of this balance is incorrect for contaminants that undergo radioactive decay. Ensuring correct mass balance requires the user to calculate the mass balance error separately from the TETRAD mass balance calculation.

C-3.4 Numerical Dispersion Limitation

The use of large time increments along with large and irregularly shaped grid blocks leads to significant numerical dispersion. This leads to additional smearing of contaminant fronts above and beyond that which would occur from the specified dispersion parameters. Although TETRAD has simulation options for dispersion control, such as higher order accurate solutions, WAG 7 simulations have been too numerically cumbersome to make this option feasible. As a result, the magnitude of simulated dispersion in the simulations is unknown but is probably greater than the assigned values. This has the potential to impact results for strongly sorbing contaminants, such as plutonium, where the bulk of the contaminant is held in the alluvium and interbeds because of sorption, and only a small dispersive component reaches the aquifer. The small portion that reaches the aquifer is attributable to an unquantified effective dispersion coefficient, which leads to uncertainty in the simulation results.

C-4. GROUNDWATER MODELING SOFTWARE CANDIDATES

A list of software features has been identified and ranked into two categories: required features and desired features. The features in these two categories are listed in Section C-4.1, and potential software candidates are briefly described in Section C-4.2.

In using the following comprehensive list of model attributes, there may not be one single code that is capable of meeting all the requirements. This may be the case where multiphase transport is necessitated by contaminants such as CCl_4 and C-14. The multiphase criterion alone could negate the selection of codes that otherwise would be perfectly and optimally suited. As a result, more than one model may be selected through this exercise.

C-4.1 Software Selection Features

The following list was derived largely from the original model selection criteria in Becker et al. (1996). Some recategorization of features has resulted based on lessons learned over the past several years, such as the need to simulate C-14 with multiphase flow.

The required modeling features include:

- Three-dimensional domain
- Heterogeneous, anisotropic media
- van Genuchten constitutive relationships
- Temporal and spatial variations in boundary conditions
- Transient sources and sinks with well functions
- Dual permeability and dual porosity
- Multiphase transport with:
    - Advection, diffusion, and dispersion in each phase
    - Phase property functions of phase constituents
    - Spatially variable partitioning of species between all phases present
    - Linear, Langmuir, and Freundlich partitioning isotherms
    - Option for Richard's equation solution (air passive)
    - Radioactive decay with progeny including separate mobility for each progeny

- Simulate up to five contaminants in single simulation.

- Mass balance accounting
- Documentation explaining model implementation and application
- Computational efficiency such that the problems implemented for OU 7-13/14 predictive simulations can be solved within 200 hours.

The desired features listed below are grouped into high (H), medium (M), and low (L) desirability. They are ranked from highest to lowest with the subcategories. The desired features include:

- H—Local grid refinement capability (finite-difference and integrated finite difference/integrated finite volume numerical simulation techniques)
- H—Integrated visual-based pre- and post-processors with data analysis tools (grid generation, kriging, and results visualization)
- H—Internal or externally coupled automated inverse parameter estimation techniques
- H—Colloidal transport simulation option
- H—Parallel processing structure
- M—Internal or externally coupled automated uncertainty analysis
- M—Familiarity by OU 7-13/14 and agency modeling staff
- M—Source-code availability
- M—Within the public domain
- M—U.S. Department of Energy (DOE) quality assurance development environment
- M—Time-dependent material properties (i.e., degradation of barriers)
- M—Nonequilibrium reactive transport
- L—Portability between operating systems
- L—Energy balance
- L—Evaporative boundary conditions and root uptake sink functions
- L—Explicit fracture simulation.

These required and desired features encompass nearly all the features that were included in the unpublished WAG 3 code evaluation effort. Only one item from the WAG 3 effort was not included in the above list. This missing item was a required criterion that a code be readily available with technical support. The items from the current list that were not included in the WAG 3 effort were van Genuchten constitutive relationships, computational efficiency, inverse parameter estimation capability, colloidal transport capability, parallel processing structure, automated uncertainty analysis, time-dependent material properties, evaporative boundary conditions, and explicit fracture simulation. These additional requirements were developed based on experience gained in performing WAG 7 simulations.

C-4.2 Candidate Groundwater Modeling Software

The previous unfinished WAG 3 code-selection effort was evaluating TETRAD, TRACR3D (Travis 1984), TOUGH2 (Pruess, Oldenburg, and Moridis 1999), FEFLOW (Waterloo Hydrogeologic 2000), PORFLOW (Analytic and Computational Research 1994), STOMP (White and Oostrom 1996), and FEHM (Dash, Robinson, and Zyvoloski 1997). With the exception of TETRAD and FEFLOW, this suite of codes has been developed within the DOE complex. Of this suite of codes, FEFLOW had not been tested yet. Although unpublished, based on the codes that had been evaluated, the WAG 3 effort would have most likely selected the STOMP simulator as the preferred code. The code evaluation effort by WAG 7 used the results of the previous investigation and focused on STOMP and TETRAD from the list of codes that WAG 3 evaluated. The unevaluated code, FEFLOW, and an additional code, MODFLOW-SURFACT, were added to this short list for evaluation. A partial description of each proposed simulator on the short list follows.

C-4.2.1 TETRAD

TETRAD software (Vinsome and Shook 1993) is a finite difference-based multipurpose simulator developed for the oil and gas industry. TETRAD for environmental simulations was first used at the INEEL. The INEEL Laboratory-Directed Research and Development Program added several features to the TETRAD software to allow simulation of environmental fate and transport problems. TETRAD software contains all of the required features listed in Section C-4.1 as well as the following desired features: (1) source code is available, (2) local grid refinement, (3) heat-transfer simulation, (4) multiple phases (gas, water, and oil), and (5) dual porosity and permeability. Limitations of the TETRAD simulator are discussed in Section C-3. TETRAD is a proprietary code.

C-4.2.2 FEFLOW

FEFLOW software (Waterloo Hydrogeologic 2000) is a finite element-based groundwater modeling system, which includes pre- and post-processing capabilities. The software is a commercial product developed by Waterloo Hydrogeologic. A description of the code can be found at http://www.flowpath.com/software/feflow/index.htm. The software contains many of the required features and the following desired features: (1) internal visualization of simulation results, (2) internal grid generation, (3) internal data interpolation options including Kriging, and (4) heat-transfer simulation. FEFLOW does not have the capability for multiphase transport. FEFLOW is a proprietary code.

C-4.2.3 STOMP

STOMP software (White and Oostrom 1996) employs the integrated finite difference technique for the numerical solution to the groundwater flow and transport equations. The software was developed at the Pacific Northwest National Laboratory as a general-purpose simulation tool for volatile organic compound and radionuclide environmental problems. A description of the code can be found at http://www.pnl.gov/etd/stomp/. STOMP software contains many of the required features and the following desired features: (1) heat-transfer simulation, (2) multiple phases (gas, water, oil, and ice), and (3) optional feature for simulating nonequilibrium reactive transport. STOMP does not have options for local grid refinement and requires rigid orthogonal grids, which would preclude use of conformable grids. STOMP is a public-domain code.

C-4.2.4 MODFLOW-SURFACT

MODFLOW-SURFACT (Panday and Huyakorn 1998) is a specialized version of the U.S. Geological Survey MODFLOW simulator developed by Hydrogeologic, Inc. A description of the code can be found at http://www.hgl.com/flash/index.cfm. The software contains many of the required and desired features. The code has capabilities for variably saturated flow and transport, up to five constituents per simulation including radioactive decay, linear and nonlinear adsorption isotherms, internal inverse modeling capabilities, options to solve only Richard's equation, and dual porosity to represent fractured porous media (no dual permeability). The multiphase flow and transport appear to have advection in the active phase and diffusion in the passive phase, which is limited compared to TETRAD and other simulators. MODFLOW-SURFACT is a proprietary code.

C-4.3 Comparison of Codes to Criteria

Table C-1 presents a comparison of the four candidate codes to the required and desired criteria. The values in the code comparison matrix in Table C-1 were developed through perusing code manuals, reading code websites and advertising literature, and conversing with code authors or users with expertise.

Table C-1. Comparison of codes to required and desired criteria.

Required Model Criteria	TETRAD	STOMP	FEFLOW	MODFLOW-SURFACT
Three-dimensional domain	Y	Y	Y	Y
Heterogeneous, anisotropic media	Y	Y	Y	Y
Van Genuchten constitutive relationships		Y	Y	Y
Temporal and spatial variations in boundary conditions	Y	Y	Y	Y
Transient sources and sinks with well functions	Y	Y	Y	Y
Dual porosity and dual permeability	Y	Dual Porosity	N	Dual Porosity
Multiphase transport capability with:				
Advection, diffusion, and dispersion in each phase	Y	Y	N	N
Property functions of phase constituents	Y	Y	N	N
Spatially variable partitioning of species between phases	Y	Y	N	Y
Linear, Langmuir, and Freundlich isotherms	Y	Y[a]	Y	Y
Option for Richard's equation solution (air passive)	N	Y	Y[e]	Y
Radioactive decay or progeny with separate mobility	Y	Y	N	Y
Simulate up to five contaminants in single simulation	Y	Y	N	Y
Mass balance accounting	Y	Y	Y	Y
Documentation explaining model implementation and application	N	Y	Y	Y
Computational efficiency to meet Operable Unit 7-13/14 simulation needs	?	?	?	?

Table C-1. (continued).

Required Model Criteria	TETRAD	STOMP	FEFLOW	MODFLOW-SURFACT
Desired Model Criteria:				
H: local grid refinement capability	Y	N	Y[f]	N
H: integrated visual-based pre- and post-processors	N	N[b]	Y	Y
H: internal or externally coupled inverse parameter estimation	Y[c]	N	Y[d]	Y[c]
H: colloidal transport simulation capability	N	N	N	N
H: parallel processing structure	N	?	?	?
M: internal or externally coupled automated uncertainty analysis	N	N	Y	Y
M: familiarity with model by Operable Unit 7-13/14 modelers	Y	N	N	N
M: source code available	Y	Y	N	N
M: within the public domain	Y	Y	N	N
M: U.S. Department of Energy quality assurance and quality control development environment	N	Y	N	N
M: time-dependent material properties	N	N	Y	N
M: nonequilibrium reactive transport	Y	N	Y	N
L: portable between operating systems	Y	?	Y	Y
L: energy balance	Y	Y	Y	N
L: evaporative boundary conditions and root uptake sink functions	N	N	N	N
L: explicit fracture simulation	N	N	Y	Y

a. Nonlinear sorption is available in other existing equations of state modules and could be added to the water-only module.

b. Development of pre- and post-processors for STOMP is planned but unfounded.

c. Both TETRAD and MODFLOW-SURFACT have been linked externally with PEST

d. FEFLOW has PEST internally built into it.

e. FEFLOW only solves dissolved-phase transport and is based on Richard’s equation.

f. Finite element methods inherently allow for local refinement.

Entries with a “?” were either unknowable or deemed not worth pursuing to completion.

C-5. SUMMARY AND CONCLUSIONS

The STOMP code essentially meets all of the required modeling criteria. STOMP is a code developed by personnel familiar with traditional soil physics terminology. Because of this, STOMP is possibly the easiest code to apply to general problems of all the codes developed in the DOE complex. STOMP is coded to allow for multiple configuration options that allow solutions to various equations of state. This is a useful and efficient approach that allows solutions for only those parameters of interest; however, the code is not at the stage of development where it would be feasible to use for the SDA. The code authors have worked on pre-and post-processors for the code, but they are doing so with inadequate funding. Only structured grids, meaning where the vertical spacing is everywhere, equivalent at a particular grid elevation can be used. There is no option to refine the base grid to increase the discretization where desired, such as is available with TETRAD. The lack of these latter two highly desired items was viewed as detrimental enough to preclude STOMP from being further considered at this time.

FEFLOW is an extremely versatile dissolved-phase flow and transport simulator. The finite element approach is well suited for simulating irregular structures, such as interbedded basalts. It has well-designed user interfaces for pre- and post-processing and has capabilities for extensive automated grid generation. FEFLOW is not, however, structured or planned for simulating multiphase flow and, therefore, will not be considered further.

MODFLOW-SURFACT appears to be only partially suitable for simulating variably saturated flow in a complex geologic setting such as the SDA. MODFLOW-SURFACT is still heavily dependent on the concept of layers, such as were used in the original code. Although MODFLOW-SURFACT allows for variable vertical grid spacing, it would be cumbersome to implement in an SDA simulation. The multiphase capacity of MODFLOW-SURFACT is limited. Only the aqueous or gaseous phase can undergo advection. Only diffusion and decay are allowed to occur in the passive phase. This is similar to the approach used before 1995 for simulating volatile organic compound fate and transport at the SDA. There is no provision in MODFLOW-SURFACT for local grid refinement.

TETRAD meets all the required criteria except for having an option that allows solutions using Richard's equation (air passive and water movement only in the aqueous phase) and adequate documentation. External pre- and post-processing capabilities have been built for TETRAD as part of INEEL simulation applications.

None of the evaluated codes have an established colloidal-transport capability. If simulation of facilitated transport becomes important for OU 7-13/14, a different code would be necessary.

The computational ability of the codes to solve the desired WAG 7 type problem was undetermined at this point for dual continua simulations that address both dissolved- and vapor-phase transport. TETRAD has been used for dissolved-phase transport problems of a similar nature, although the simulations sometimes ran longer than 200 hours.

Based on the evaluation of code capabilities, the TETRAD simulator was still the optimum code to use for subsurface pathway flow and transport simulations. Each of the alternative evaluated codes has desirable features, but none are adequate enough on their own to justify switching to a new simulator. Although the STOMP code contained all of the required features, the highly desired feature of local grid refinement was key enough to sway the decision on which code to select. The use of grid refinement is highly embedded in the OU 7-13/14 simulation process. Obtaining equivalent discretization capabilities with the STOMP is not anticipated to be computationally feasible at this time.

Regarding TETRAD limitations discussed in Section C-3, the first two limitations are being mitigated through a Laboratory-Directed Research and Development Program project that is making the scaling independent across the range of components being simulated, which also is improving the computational efficiency. The mass balance, when decay is present, is still present as is the uncertainty regarding numerical dispersion. As the latter has always been present in OU 7-13/14 simulations to date and these simulations have been satisfactory, this limitation is not significant enough to preclude continued use of the TETRAD simulator.

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Appendix D

Source Term Model Evaluation

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Source Term Model Evaluation

The source term model is used to compute container failure and contaminant release into the shallow subsurface. The output from this model is used as input to the biotic uptake and vadose zone transport simulations. Thus, it is the crucial first step in estimating risk posed by contaminants in the Subsurface Disposal Area. The *Interim Risk Assessment and Contaminant Screening for the Waste Area Group 7 Remedial Investigation* (Becker et al. 1998) identified the model selection criteria and the code to be used. The model selection criteria are presented in Table D-1. The code selected was DUST-MS. Limitations in the code were identified during the *Interim Risk Assessment*, and modifications to the code were implemented before the *Ancillary Basis for Risk Analysis of the Subsurface Disposal Area* (Holdren et al. 2002). Model selection criteria and available codes were reviewed to determine if DUST-MS remains the best choice for Operable Unit 7-13/14. The conclusion was reached that it is. This appendix summarizes the review.

The conceptual model of source release is that the waste is disposed of in containers, and, once the containers fail, the contaminants are available for release. DUST-MS allows the simulations of container failure and three release mechanisms. The selection criteria identified in Table D-1 are still appropriate for the remedial investigation/baseline risk assessment. DUST-MS has been modified to better match the selection criteria and so is an even better choice than when it was first selected.

A literature review was conducted to determine if other models exist that have expanded capability and offer an improvement over DUST-MS. The review identified *Data Catalog of Models Simulating Release of Contaminants from Hanford Site Waste Sources* (Riley and Lo Presti 2001), which lists the models used at Hanford for this type of simulation. This report shows that many groups wrote their own code to simulate the same or similar release models as are already incorporated into DUST-MS. Changing to any of these other models would provide no benefit in terms of the conceptual model and would require additional work as the interface between the model and the other simulations must be rewritten.

In addition, an independent review of the DUST-MS model was performed for the grout project, and the results again support the use of DUST-MS. The letter summarizing the review is included as an attachment. This review looks at the conceptual model and the data available to support the modeling. The report recommends research to develop data necessary for a reactive transport simulation that accurately models the local geochemistry but recognizes that, at the current time, the data are not available to support such a simulation. The review recommends care in the selection of input parameters, use of geochemical data to support that selection, and use of DUST-MS as an appropriate tool for the remedial investigation and for comparing remedial options for the feasibility study.

In summary, a brief review was performed of the available models, and the conclusion of the review is that DUST-MS is still appropriate for use in the Operable Unit 7-13/14 comprehensive remedial investigation/feasibility study.

Table D-1. Comparison of the DUST-MS code to the source term model selection criteria.

Model Criteria	DUST-MS
Required	
Capable of mass balance accounting	Yes
Capable of handling containment failure	Yes[a]
Capable of handling multiple release mechanisms (e.g., diffusion, corrosion, and leaching)	Yes[b]
Capable of handling radionuclide decay chains	Yes
Compatible with biotic, atmospheric and subsurface pathway models	Yes[c]
Well documented with an explanation of the model application and implementation	Yes
Desired	
Available within the public domain	Yes
Compatible with an available source code	Yes
Portable and efficient	Yes
Readily obtainable	Yes
Familiar to the relevant modelers	Yes
Other	
Capable of time dependent infiltration	Yes[d]
Capable of time dependent waste emplacement	No[e]

a. Either failure time or local pitting parameters can be specified.

b. DUST-MS has three waste release mechanisms: diffusion, dissolution and surface wash off.

c. Interface should be similar to program developed for BLT.

d. DUST-MS allows variable infiltration, but uses a constant moisture content.

e. Choice of container failure time could be used to simulate time dependent waste emplacement.

D-1. REFERENCES

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INTEROFFICE MEMORANDUM

Date:	July 19, 2000		
To:	James J. Jessmore	MS 3710	6-7558
From:	Larry Hull	MS 2107	6-1922
Subject:	COMMENTS ON THE USE OF DUST FOR SOURCE TERM MODELS FOR THE OU 7-13/14 RI/BRA - LCH-09-00		

This memo is to follow up on our meeting of July 17, 2000 where we discussed source term models for the OU 7-13/14 RI/BRA. After further analysis of the DUST source term simulation code (Sullivan 1996), I would recommend that the DUST code be used for the source term work for OU 7-13/14. I had one reservation about the code, which I have since resolved by a phone conversation with the code author, Terry Sullivan of Brookhaven National Laboratory. My reservation concerned concentration of a contaminant in a waste form during release by diffusion. A solubility limit is imposed inside the waste form during diffusion, limiting the maximum availability of a contaminant to that controlled by mineral solubility.

There are a number of other constraints imposed by DUST, but I think that with reasonable assumptions, the code will provide meaningful output to compare remedial alternatives for the SDA. The use of a single approach to all feasibility alternatives for the SDA will provide the most comparable results for the feasibility study. Even if there is considerable uncertainty in the absolute numbers, the relative risk reduction of various treatment alternatives (hot spot removal, grout, vitrification) can be evaluated. The DUST code could also be used to perform a sensitivity study to fracturing on the release of contaminants from grout waste forms.

The DUST code will not handle the release of volatile organic compounds through the vapor phase, but could possibly be used to provide source release information in a form that TETRAD could accept and use for the volatile organic compounds. With the proper diffusion coefficient and solubility limit, diffusion of volatile organic compounds out of waste forms and containers could be simulated using the release model in DUST. The mass released to the soil around a container or waste form could be passed to TETRAD, where TETRAD would handle the partitioning between vapor, aqueous, and NAPL phases.

The DUST code does not have a spatial component to the output. DUST provides one output number from the inventory. Therefore, the SDA will have to be descritized, the inventory in each block quantified, and DUST run on each grid block. Conversely, DUST could be run on each pit and on some combination of trenches. The release from DUST could then be distributed among the grid blocks that include those pits and trenches. Neither approach poses any significant problems. Probably, running DUST on natural divisions such as pits would be a better approach. This will provide the easiest way to quantify risk reduction from various treatments since treatments will undoubtedly be selected by identifiable units (such as by pit). Even hot-spot removal could be accommodated by dust set up in this way.

What cannot be handled by DUST is a treatment of the geochemical reactions taking place in the waste. After further consideration on this subject, I am not sure that we currently know enough to use a reactive geochemical approach to the source term at the SDA. Once the characterization instrumentation is installed in the pits at the SDA, we will begin to develop the necessary information. I would recommend a two pronged approach to this issue.

1. Adopt DUST as the source term model for the SDA, and begin to develop the conceptual models and input parameters for DUST.
2. Measure geochemical parameters (water chemistry, redox potential, organic compounds, microbial activity, radionuclide concentrations) in the pits and develop mechanistic computer models of waste degradation and mobilization.

The DUST code, like a transport code that uses K_d to simulate water-solid partitioning, is a lumped parameter model. An understanding of the processes behind the lumped parameters and that justify the values of the parameters used in the models, provides a stronger technical basis for the risk assessment than the use of lumped parameters without such an understanding.

In April, I sent you a scope of work and tasks that were more oriented towards a mechanistic geochemical approach to the source term. There are some changes to that list based on these current recommendations.

Task 1. Fracture assessment – This task was to assess the effect of fracture intensity of a grout waste form on the release of contaminants from the waste form, and to define, if possible, the maximum fracture intensity that was acceptable. Development of fractures over time in a monolithic waste form cannot be addressed by DUST. However, multiple monoliths can be simulated. Therefore, fracture intensity can be modeled by dividing the monolith volume and inventory into more and more smaller monoliths. This mimics the increased surface area of a fractured grout waste form. Therefore, this task remains unchanged, except that DUST would be the chosen tool to evaluate the effect of fracturing.

Task 2. Grout chemistry and geochemistry – The need for this task in FY 2000 goes away, but this would still be an important task to develop a mechanistic understanding of radionuclide release from grouts. Delay this task into next fiscal year.

Task 3. Multi-dimensional source term model – This task was to develop a multi-dimensional source term model for the SDA. However, by using DUST to simulate each of the pits and some collection of trenches, input tables for TETRAD can be developed. This task is no longer needed.

Task 4. Geochemical modeling of source release – As with Task 2., this task can be moved into FY 2001 and be coupled more closely with the collection of geochemical information from the pits in the SDA.

Task 5. Simulation of the grout source term – This task can proceed as planned, or even start sooner as less development time is needed if DUST is being used.

If DUST is used for all of the source term models, a significant amount of cooperative development is needed for the various treatments (none, removal, grout, and vitrification). A coordinated DUST development effort is needed to provide a uniform and comparable implementation for the feasibility study. I recommend that the three project managers (Becker, Jessmore, and Nickelson) coordinate this effort into one performing organization so that comparable results are obtained. This task should begin soon to develop the conceptual model and implementation strategy.

reference:

Sullivan, Terry M., 1996, *DUST–MS Disposal Unit Source Term Model Equations for Waste Form Leaching and Transport with Ingrowth Due to Radioactive Decay*, Brookhaven National Laboratory.

lch:

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